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ABSTRACT

This instructor's guide contains materials for teaching the heating and air conditioning specialist component of a competency-based instructional program for students preparing for employment in the automotive service trade. It is based on the National Institute of Automotive Service Excellence task lists. The six instructional units presented contain materials on the following topics: introduction to air conditioning, refrigeration system, air conditioning mechanical and electrical controls, heating mechanical and electrical controls, heating, and automatic and semiautomatic controls. Each unit includes the following: performance objectives, suggested activities, pretests, information sheets, assignment sheets, job sheets and their practical tests, written tests, and answers to all tests and assignments. Some units also include handouts, supplements, transparency masters, and activity sheets. Transparency masters, handouts, pretests, practical tests, and thirteen tests are included in the instructor edition only. All unit components focus on measurable and observable learning outcomes, and all units incorporate activities to help students master basic skills required for the workplace. In addition, each unit includes information on the following: using the materials for independent study, amounts of material to cover in single class periods, skills that must be demonstrated, supplies/equipment needed, amounts of class time required for demonstrations and student practice, supplementary materials to order, and resource people to contact. (MN)

ED 385 676

Automotive Service Series

Heating and Air Conditioning Specialist

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CIMC

Teacher Edition

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Oklahoma Department of
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1500 West Seventh Avenue
Stillwater, OK 74074-4364

TI 1231

Heating and Air Conditioning Specialist

Developed by the
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for the Division of Trade and Industrial Education
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Heading and Air Conditioning Specialist

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FOREWORD

This is one in a series of eight automotive service specialty publications that is based on the National Institute of Automotive Service Excellence (ASE) task lists. This series provides instruction for all high-priority competencies established by ASE and will contribute greatly to an auto service technology program's ability to meet the requirements of a nationally certified training school.

The ASE competencies are developed by industry to meet the industry's need for quality technicians. This curriculum addresses that need. The industry and education committee that has validated the technical accuracy of this material is commended for outstanding service and commitment to the quality of these instructional units. The instructors and students who use this material are challenged to have the same commitment to excellence.

We trust that this instructional material will meet students' needs as they prepare for careers in heating and air conditioning specialist.

Dr. Roy Peters, Jr., State Director
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Oklahoma Department of
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PREFACE

The purpose of *Heating and Air Conditioning Specialist* is to continue the students' training in the automotive service trade by providing instruction in this specialty area. This publication is one in a series of eight publications for automotive specialty areas. Other areas included in this series are brakes, steering and suspension, engine repair, engine performance, electrical, manual drivetrain and axles, and automatic transmission/transaxle.

Instructors are faced with the challenge of teaching the skills and related information necessary for their students to become the highly-qualified automotive service specialists that are in demand today. This curriculum is designed to help instructors meet this challenge. The objectives in this curriculum are based on those National Institute of Automotive Service Excellence (ASE) tasks that are required of a heating and air conditioning technician.

Dr. Gayle A. Kearns
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ACKNOWLEDGEMENTS

The Curriculum and Instructional Materials Center (CIMC) extends its appreciation to those individuals who played important roles in the development of *Heating and Air Conditioning Specialist*. To the writers, Mr. Jerry Rau and Sandra Dutreau Perky Williams, your work is to be commended.

Special appreciation is extended to the professional automotive technicians and vocational educators who so generously contributed their substantial expertise, talents, and time to serve on the *Heating and Air Conditioning Specialist* curriculum validation committee.

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Only with the close cooperation of the Curriculum and Instructional Materials Center staff was this curriculum developed. Sincere thanks are shared with Dr. Brenda Stacy, CIMC Coordinator and Dr. Lynna Ausburn, Development Coordinator.

Special appreciation is offered to the other individuals on the CIMC staff who functioned in important supportive roles throughout the development of the *Heating and Air Conditioning Specialist* curriculum: Barbara Kuehl, secretary, who provided all correspondence support with committee members; Terri Tomson, secretary, who provided a great deal of assistance, including the organization of the tracking of permission letters for the illustrations; and Camille Baker, Beth Ann Chlouber, Lynnette Johnson, and Connie Romans, Technical Writers, who proofread the final copy. Thanks also to the many other members of the CIMC staff who so generously provided the support, help, and advice that was needed for this project.

Special recognition and thanks are also extended to other individuals within the Oklahoma Department of Vocational and Technical Education involved in the development process: Rose Primeaux and Margie Kirkendall in the Word Processing Center; Bob Davis in the Art Department, with special appreciation to artists Gary Bradley, Kim Hale, Candy Haun, Colin McLain, Kathryn Moore, Suzanne Morris, Robert Randall, Wilna Tannahill, and David Thompson; Noel Wilcoxson, Frosty Foster, and Diane Ensign and their staffs at the ODVTE Print Shop; Karen Williams and her staff in the Resource Center, particularly Lois Heid, instructional media specialist.

And finally, a very special acknowledgment goes to Chuck Pendergast, the technical advisor for this project, without whose expert collaboration, advice, support, review, and encouragement this curriculum would not have been possible.

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USE OF THIS PUBLICATION

INSTRUCTIONAL UNITS

Heating and Air Conditioning Specialist contains six units. Each instructional unit includes basic components that form a unit of instruction: performance objectives, suggested activities, pretests and pretest answers, information sheets, assignment sheets and assignment sheet answers, job sheets and their practical tests, and written tests and written test answers. Handouts, supplements, transparency masters, and activity sheets are optional components which may be included in some or all of the units. Transparency masters, handouts, pretests, practical tests, and written tests are included in the instructor edition only and may be duplicated for classroom use. Test packets may be purchased in Oklahoma by calling 1-800-522-5810. Out-of-state instructors may order test packets by calling 1-800-654-4502.

The unit components focus on measurable and observable learning outcomes. Instructors are encouraged to supplement, personalize, localize, and motivate with these materials in order to develop a complete teaching/learning process.

Units of instruction are designed for use in more than one lesson or class period of instruction. By carefully studying each unit of instruction, the instructor will be able to plan presentations and demonstrations to meet the needs of the students as well as determine the following:

- How to use the materials for independent study
- Amount of material to cover in a single class period
- Skills that must be demonstrated
- Supplies and equipment needed
- Amount of class time required for demonstrations
- Amount of class time required for student practice
- Supplementary materials to order, such as pamphlets, videos, or software
- Resource people to contact

Objective Sheets (White Pages)

Each unit of instruction is based on the knowledge and skills needed for successful employment in an occupational area. What the student must know and be able to do has been translated into performance objectives which are stated in two forms. ***Unit objectives*** state the subject matter to be covered in a unit of instruction, what the student should be able to do and what standard will be used to determine whether the student has achieved competency. ***Specific objectives*** outline the teaching sequence and state the performance necessary to meet the unit objective.

The objectives can also help determine teaching strategies and instructional methods. Instructors will need to decide how each objective can best be taught (individualized or class instruction) to their students prior to beginning the unit. Instructors should feel free to modify, delete, or add objectives in order to meet the needs of the students and the community. If objectives are added, the instructor should remember to supply the needed information, assignment sheets, job sheets, practical tests, and criterion test items.

Suggested Activities (Pink Pages) — **Instructor's Edition Only**

This component assists the instructor during the preparation stage of the teaching/learning process by providing suggestions for delivery, enrichment, and application during the instructional process. Teaching suggestions are included for each objective. The instructor should read the suggested activities before teaching the units to allow time to obtain supplemental materials, prepare audiovisual materials, and contact outside resources. Duties of the instructor will vary according to the particular unit.

Included in this component are suggested resources of books, audiovisual materials, and software which may be used to teach the unit. References used in the development of each unit are also provided. Instructors can use suggested resources and unit references to supplement their knowledge of the subject or to help students with particular interests or occupational objectives in the subject area.

Handouts (White Pages) — **Instructor's Edition Only**

Handouts are additional teaching aids that support portions of the information sheet by providing "nice-to-know" information which is not testable. They may include activities such as games, puzzles or supplementary information on subjects that are considered to be controversial. The instructor may decide whether to duplicate and use handouts in teaching the unit.

Pretests (Yellow Pages) — **Instructor's Edition Only**

Because students bring a variety of background experiences and knowledge to the classroom, pretests are included to allow the student the opportunity to demonstrate previously gained information. The pretest provides a criterion-referenced tool for evaluating students' knowledge prior to studying the unit. For a description of this component, please refer to the written test description.

Pretest Answers (Pink Pages) — **Instructor's Edition Only**

This component is designed to assist the instructor in evaluating student performance on the pretest.

Information Sheets (Green Pages)

The information sheets provide "must know" content that is essential for meeting the cognitive objectives. The information sheets serve as an excellent guide for presenting background knowledge necessary to develop the skills specified in the unit objective.

Students should read the information sheets before the information is discussed in class. Space is provided in margins for students and instructors to add notes that supplement, localize, personalize, or provide motivation for each unit. Program coordinators, directors, and/or instructors are encouraged to select and acquire textbooks for students in order to supplement and expand the material covered in the information sheets.

The information sheets may include notes, cautions, or warnings. These should be discussed carefully and thoroughly. ***Notes*** are short verbal additions to the information that provide nice-to-know and decision-making information. A note may tell the student what to look for or consider at a given step or may explain when a step may not be applicable. Notes offer guidance that may help the student understand the process and accomplish it more efficiently. ***Cautions*** are advisories that alert students to conditions or situations which may result in physical damage to themselves, the vehicle, or equipment. ***Warnings*** are advisories that alert the student to dangers which may result in critical or fatal damage to themselves or major damage to the vehicle or equipment.

Supplements (Green Pages)

Supplements include material that provides additional information for understanding the topic but may not have direct application to specific objectives. Instructions that might be used for solving problems, tables, charts, written information, forms, or other information students might need in order to complete one or more of the assignment or job sheets could be included as a supplement. While information in supplements is not tested directly, it may be used to assist the student in meeting the performance objectives.

Transparency Masters (White Pages) — **Instructor's Edition Only**

Transparency masters provide information in a special way. They direct the class's attention to the topic of discussion and allow the instructor to illustrate the topic. The use of transparencies is especially effective for visual learners who prefer to see the topic being presented as well as hear about it. Transparencies may present new information or they may reinforce information presented in the information sheets. Transparencies should be made ahead of time and placed with the rest of the materials necessary to teach the unit.

Activity Sheets (Tan Pages)

Activity sheets provide activities which support several objectives or deal with students' attitudes, beliefs or appreciation of the study area. Some may ask rather personal questions and are only intended for each student's personal use while other activity sheets may require the student to monitor his or her own actions or other personal variables over a period of time. Activity sheets will vary greatly in their design from unit to unit. When Activity Sheet Answers (pink pages) are provided, they are found only in the Teacher's Edition.

Assignment Sheets (Tan Pages)

Assignment sheets provide written exercises for instruction and practice of a specific objective. The introduction to the assignment sheet explains how the assignment sheet relates to the subject area and unit objectives and may provide instructional information or refer students to another component for such information.

Assignment sheets are intended to provide students with practice in exercising higher-order thinking skills. Often assignment sheets will contain case studies, story problems, or other situations in which the student must analyze the circumstances and determine correct responses. Students may be given assignment sheets in class or as homework.

Assignment Sheet Answers (Pink Pages) — **Instructor's Edition Only**

This component is designed to assist the instructor in evaluating student performance on assignment sheets.

Job Sheets (Blue Pages)

Job sheets provide a list of equipment, tools, and materials needed to complete a manipulative or psychomotor skill. They describe a step-by-step procedure to complete each task or job. Diagrams, photographs, and illustrations may be included to assist students in achieving the skill.

The instructor should demonstrate the procedures outlined in each job sheet. Furthermore, the instructor needs to localize the procedure according to the equipment and supplies available in the local lab situation. Job sheets also show potential employers what skills the students are learning and the performances they might reasonably expect from students who have had this vocational instruction.

Practical Tests (Yellow Pages) — **Instructor's Edition Only**

Practical tests assist the instructor in evaluating the psychomotor activities (job sheets). The practical tests provide instructors with a valid mechanism for determining a student's level of ability to perform the procedure stated on the job sheet and a means of evaluating the student's final product.

Written Tests (Yellow Pages) — **Instructor's Edition Only**

This component provides criterion-referenced evaluation of every objective listed in the unit of instruction. All performance objectives will be evaluated. If objectives have been added, deleted, or modified, appropriate changes should be made on the written test.

The tests may be written or oral. It may be advisable to divide the tests into shorter tests covering three or four objectives at a time and give them soon after those objectives are covered.

The acceptable response on a written test, eighty-five (85) percent in most units, applies to the overall score, not to each individual question. The final unit grade should be obtained by combining written test and assignment sheet scores with evaluation ratings on the practical tests.

Written Test Answers (Pink Pages) — **Instructor's Edition Only**

This component is designed to assist the instructor in evaluating student performance on the written test.

PAGE NUMBERING

Each publication for the CIMC is assigned a specific abbreviation or will be recognized by the book title. *Heating and Air Conditioning Specialist* will be referred to by "HACS." Each unit is identified by the unit number in Roman numerals followed by the page number. The first page of each unit is always page 1. The component name, book title, unit number, and page number within the unit are printed at the bottom of each page. An example of the page footer for an objective sheet in *Heating and Air Conditioning Specialist* is shown below.

OBJECTIVE SHEET - HACS
I - 1

METHODS OF DISSEMINATING MATERIAL

Each student should be provided with a student workbook. Workbooks may be purchased for less than an instructor can reproduce them, especially when the instructor's time is considered. Student workbooks contain everything but the suggested activities, pretests, pretest answers, handouts, transparency masters, activity sheet answers, assignment sheet answers, practical tests, written tests, and written test answers. Test packets may be purchased from the Curriculum and Instructional Materials Center. Students should be allowed to take their workbooks home when they complete the program.

TEACHING METHODS

It is a challenge to keep students motivated. Instructors can supplement the objectives by providing the "why," personal experiences, and current information. Preparation for each unit should be determined by how each objective can best be taught. Students should become involved in preparing and planning for each unit.

If the material will be utilized in an individualized instruction situation, instructors should provide opportunities that will allow students to become involved in planning for and being responsible for their own education.

COMPETENCY PROFILES

A competency profile is available for each CIMC publication. Competency profiles document student performance. The profile contains a list of the specific job competencies that a student should achieve before leaving the training program. Profiles should be distributed to students as needed.

DISCLAIMERS, CORRECTIONS AND SUGGESTIONS

Materials

Please note that suggested resources and references listed in this publication existed when this publication was written. CIMC assumes no responsibility for providing these materials and cannot ensure the availability of these materials as individual vendors, manufacturers, and publishers may discontinue these products at any time.

Safety

The Curriculum and Instructional Materials Center (CIMC) wants to provide vocational instructors and students with materials that are accurate and effective. Although the CIMC strives to maintain the highest standards of development and production, oversights occasionally do occur. The CIMC assumes no responsibility for any adverse effects resulting directly or indirectly from information, suggested procedures, undetected errors or the reader's misunderstanding of the information presented.

Corrections and Suggestions

If you find any errors in this or other CIMC publications or have suggestions for improving their usefulness in vocational programs, please notify the CIMC staff. One easy way of pointing out errors is to make a photocopy of the affected page and to indicate the correction on the copy. Mail this information to the CIMC, where it will be used to correct the publication before the materials are reprinted.

To ensure that the material is updated on a timely basis, notify the CIMC of necessary corrections as soon as possible after discovering the error. Do not assume that someone else will notice the error and inform the CIMC; other users may be making the same assumption. Please send corrections and recommendations for improving this publication to the following address:

Curriculum and Instructional Materials Center
Oklahoma Department of Vocational and
Technical Education
1500 West Seventh Avenue
Stillwater, Oklahoma 74074-4364

BASIC SKILLS IN CIMC MATERIALS

Preparing students to enter successfully into today's world of work offers vocational education a substantial challenge. The contemporary workplace is characterized by constant and rapid technological change and by increasing job complexity and skill intensity. Due to rapid technological advancement, the half-life of work skills is now reduced to a bare three to five years. Out of this new workplace environment has arisen a growing awareness of the critical importance of an American workforce armed with the skills necessary to survive in a competitive economy.

One result of this national awareness has been the emergence of a renewed emphasis on basic academic skills in all areas of education. Pressure to increase academic skill development is being placed on education by both legislative action and industry mandate. The Carl D. Perkins Vocational and Applied Technology Education Act of 1990 sets stringent basic skill requirements for vocational education. State legislatures are increasingly requiring basic skills accountability by teachers and school administrators. Graduation exams, minimum competency requirements, and expected learner outcomes are being implemented with increasing frequency. In addition, business and industry are delivering the message clearly to educators that vocational competence now requires increased strength in the basic skills.

The issue of the basic skills currently required in the work place was very successfully addressed in a recent national three-year study conducted jointly by the American Society of Training and Development (ASTD) and the U.S. Department of Labor (DOL). The findings of this study were published in 1990 in the book, *Workplace Basics: The Essential Skills Employers Want.*

The ASTD/DOL research indicates clearly that American employers have discovered that their workforces need a variety of skills that include, but are not limited to, the classic academic trio of reading, writing, and computation. Employers now are also looking for competence in areas such as "learning to learn," problem solving and critical thinking, interpersonal and teamwork skills, oral communication and listening techniques, and the social and personal management skills that demonstrate a capacity for independence and responsibility in on-the-job performance.

It is clear that the requirements of today's business and industry have expanded and re-defined "workplace basics." It is in line with the re-definition and with the competency requirements of current education legislation, that the Oklahoma Department of Vocational and Technical Education has chosen to address "basic skills" in the instructional materials produced by its Curriculum and Instructional Materials Center.

It is not a new development for CIMC materials to contain information and activities which develop basic skills competencies in students undertaking vocational programs. What is new is the specific marking, or flagging, of items in our instruction materials that address basic skills.

To assist teachers and students in identifying activities which promote basic skills development, CIMC has implemented a marking system which uses simple graphic symbols or icons. These icons are located in the left margins of assignment sheets, activity sheets, and job sheets. The following is an explanation of the icons and the kinds of basic skill activities they indicate.

1. **READING SKILLS:** Skills involving use of print resource material for obtaining and applying information.

Current vocational education literature indicates that functional literacy as a workplace basic needs to be defined in terms of reading competencies actually required for job performance. The activities identified with this icon addressing reading skills in CIMC materials deal specifically with developing reading skills in an applied, job-related context. These range from general information-gathering activities to tasks requiring use of specific technical reference materials. Many contain a "learning to learn" aspect which promotes engaging actively and purposefully in vocationally relevant inquiry.

2. **WRITING SKILLS:** Skills involving written communication of processes, information, or ideas.

Tasks identified with this icon promote development of skills in written communications. As with reading skills, the writing skills emphasized in CIMC materials have a vocational context. They include filling out forms, keeping work activity records, writing simple memos and letters, generating more complex reports and articles, and written expression of ideas and concepts related to vocational performance or exploration.

3. **MATHEMATICS SKILLS:** Skills involving computation, calculation, and interpretation of numerical data.

This icon identifies activities which develop vocationally-related skills in computation, measurement and estimation, selection and application of appropriate mathematical processes, and collecting, displaying, or interpreting data.

4. **SCIENCE SKILLS:** Skills involving mastery and application of scientific information or theory.

This icon marks activities which are related to the development of skills in either the physical or biological sciences. These skills stress occupationally-related application of science and technology.

5. **ORAL COMMUNICATION SKILLS:** Skills involving speaking and listening.

Activities marked with this icon promote development of effective speaking and listening. They include practice in such areas as speaking techniques, word choice, non-verbal messages, use of communication media, and using active listening techniques. Many of these activities promote "learning to learn" skills in verbal inquiry.

6. **INTERPERSONAL OR RELATING SKILLS:** Skills involving working and getting along with others.

Activities which deal directly with skills in relating to others are marked with this icon. This includes areas such as multi-cultural awareness, group processes and dynamics, negotiation, dealing with conflict, cooperation and teamwork, values and attitudes, and leadership and motivation.

7. **CREATIVE THINKING AND PROBLEM SOLVING SKILLS:** Skills involving comprehending, applying, analyzing, and developing complex ideas and situations.

This icon identifies activities which stress development of higher-order thought processes such as problem identification and analysis, lateral thinking, evaluating alternatives, developing solutions, examining assumptions, and evaluating outcomes.

8. **EMPLOYABILITY SKILLS:** Skills involving choosing, obtaining, and succeeding in a career.

Activities marked with this icon relate to competencies required to obtain employment and develop a career. These competencies include specific occupational tasks. They also include items such as career analysis and selection, job searching, completing applications and resumes, interviewing, business etiquette, and personal management skills required for job-keeping and maturing in one's work. Examples of the later category include personal presentation, self-discipline, work accuracy, reliability, discretion, punctuality, handling stress, judgment, confidence, etc.

9. **SOCIAL STUDIES SKILLS:** Skills involving investigation and application of social concepts.

This icon marks activities which stress competencies in fields relating to human society and its distribution and relationships. This includes areas such as history, geography, demographics, current events, cross-cultural studies, consumer issues, environmental issues, and ethical concerns in science and technology.

Some activities in CIMC materials develop skills in more than one of the eight basic skill areas. In cases where the relative strengths of the skill elements are clearly discernable, the identification icon used is the one judged to be the primary, or strongest, element in the activity. For some activities, more than one icon is used, indicating equal strength of basic skills components in the activity.

The use of graphic icons to identify basic skills in CIMC instructional materials is the first in a series of steps designed to foster basic skills development in vocational students and accountability for vocational teachers. The Oklahoma Department of Vocational and Technical Education has developed a staged implementation strategy for integrating basic skills into CIMC materials. Additional basic skill elements in future CIMC publications will reflect the advancement of this staged implementation

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OBJECTIVE SHEET

INTRODUCTION TO AIR CONDITIONING

I

INTRODUCTION

The air conditioning (A/C) process is interesting. The air temperature is reduced not by adding cooler air, but by removing the heat. Less heat means cooler air. The removal of heat in cars is accomplished by using the chemical known as refrigerant R-12. It consists of one carbon atom linked to two chlorine and two fluorine atoms.

R-12 is presently used for auto air conditioning since it can be changed from liquid to gas by a relatively small pressure change. As a gas, R-12 can absorb heat, thereby producing cool air. The cool air is then blown into the passenger compartment of the car. R-12 is currently being phased out due to the damage it causes to the ozone layer.

This unit concerns the mechanical system that carries refrigerant. As with any mechanical system, the air conditioning system may have problems. These problems bring about repair needs. In this unit, the student will learn about the most common and most abused repair need: adding more refrigerant to the system. The student will also learn how to rid the system of refrigerant in order to perform maintenance on the components of the air conditioning. Finally, the student will learn how to diagnose problems from various effects.

UNIT OBJECTIVE

After completing this unit, the student should be able to identify components of the air conditioning system; use test equipment to check these systems; and change the refrigerant. The student will demonstrate these abilities by completing the assignment sheet, job sheets, practical tests, and a written test with a minimum of 85 percent accuracy.

PREREQUISITE

Introduction to Automotive Service: Electrical Systems Specialist

SPECIFIC OBJECTIVES

After completing this unit, the student should be able to

1. Match terms associated with air conditioning to their definitions.

2. State the functions of the components of the air conditioning system.

3. Arrange in order the steps of the air conditioning process.

4. Distinguish between the "high-side" and "low-side" of the air conditioning system.

5. Label the two main types and parts of the air conditioning system.

6. List safety precautions for working on the air conditioning system.

7. Match air conditioning system contaminants to their effects.

8. State the functions of air conditioning test equipment.

9. Interpret a gauge chart. (Assignment Sheet 1)

10. Demonstrate the ability to:

    a. Perform a system test with a manifold gauge. (Job Sheet 1)

    b. Perform a leak test with a flame leak detector. (Job Sheet 2)

    c. Perform a leak test with an electronic leak detector. (Job Sheet 3)

    d. Discharge the system. (Job Sheet 4)

    e. Use a refrigerant recycling center. (Job Sheet 5)

    f. Inspect the A/C oil level. (Job Sheet 6)

    g. Evacuate the system. (Job Sheet 7)

    h. Charge the system. (Job Sheet 8)

    i. Use a charging station. (Job Sheet 9)

SUGGESTED ACTIVITIES

INTRODUCTION TO AIR CONDITIONING

I

PREPARATION

- Review unit and plan presentation.
- Determine scope and sequence of objectives that you add. Design and develop support materials, including evaluation techniques, for additional objectives.
- Review teaching suggestions and plan classroom activities.
- Determine how you will schedule time for students to demonstrate competence in the required procedures.
- Order materials to supplement unit.
- Request a catalog to order bulletins and manuals on a range of heating and air conditioning topics from:

  Four Seasons Division
  Standard Motor Products, Inc.
  1-800-433-7508 (in Texas, 1-800-772-7824)

- Invite a local heating and air conditioning specialist to the class.

  NOTE: Supply guest speakers with the Objective Sheet, Information Sheet, and any other components you want them to cover.

DELIVERY

Objective 1 Match terms associated with air conditioning to their definitions.

- Help the students learn basic terms used when discussing auto air conditioning.
- Review terms they are already familiar with and stress learning new terms.

Objective 2 State the functions of the components of the air conditioning system.

- Explain how the pressure in the system starts in the compressor—pumping refrigerant throughout the system.

Objective 3 Arrange in order the steps of the air conditioning process.

- Show how components are interrelated.
- Note that the refrigerant moves in a circle.
- Introduce the idea that refrigerant changing from liquid to gas in the evaporator is a heat absorption process.

Objectives 4 and 5 Distinguish between the "high-side" and "low-side" of the air conditioning system, and label the two main types and parts of the air conditioning system.

- Stress that the change in pressure from the high-side to the low-side is actually the cooling process.
- Note that refrigerant's ability to undergo these changes in pressure makes it ideal for auto air conditioning.
- Discuss the different parts in terms of the whole.

Objective 6 List safety precautions for working on the air conditioning system.

- Stress the importance of safety goggles.
- Stress the importance of keeping refrigerant away from open flames.

Objective 7 Match air conditioning system contaminants to their effects.

- Explain how moisture affects the system.
- Note that any contaminant will damage the system.
- Explain why flushing is necessary.
- Explain to the students this is why purging hoses in the system is necessary and why proper evacuation must be performed.

Objective 8 State the functions of air conditioning test equipment.

- Show the students that the manifold gauge will diagnose almost any problem.
- Explain how ambient temperature affects gauge readings.

APPLICATION

Objective 9

Assignment Sheet 1 Interpret a gauge chart.

- Use Assignment Sheet 1 to help the students use a manifold gauge.

Objective 10 Demonstrate the ability to

- Perform a system test with a manifold gauge. (Job Sheet 1)
- Perform a leak test with a flame leak detector. (Job Sheet 2)
- Perform a leak test with an electronic leak detector. (Job Sheet 3)
- Discharge the system. (Job Sheet 4)
- Use a refrigerant recycling center. (Job Sheet 5)
- Inspect the air conditioning oil level. (Job Sheet 6)
- Evacuate the system. (Job Sheet 7)
- Charge the system. (Job Sheet 8)
- Use a charging system. (Job Sheet 9)
- Use Job Sheets 1-9 to help students learn to perform basic tests and maintenance procedures.

EVALUATION

Pretest

- Pretest qualifying students.
- Determine individual requirements from pretest results.

- Counsel students individually on pretest results and study requirements.

Practical test

- Explain to students that they will be asked to demonstrate procedures on the job sheets to complete the practical test.

- Describe the rating scale used on the practical test.

- Reteach and retest as necessary.

Written test

- Explain to students that they will be asked to demonstrate on the written test actions listed in the specific objectives.

- Give written test.

  NOTE: The written test may be given in sections if desired.

- Evaluate students on assignment sheet activity if not previously done.

- Reteach and retest if necessary.

- Complete appropriate section of competency profiles.

- Review individual and group performance in order to evaluate teaching methods. Adjust scope, sequence, or instructional approaches for additional lessons as required.

SUGGESTED RESOURCES

Media

- *Air Conditioning Compressor Seal Service.* OL. MI-8011V-TTS. Available from Career Aids Division, 20417 Nordhoff St., Dept. R 4 5, Chatsworth, CA 91311.

- *Air Conditioning Diagnosis.* OL. MI-8009V-TTS. Available from Career Aids Division, 20417 Nordhoff St., Dept. R 4 5, Chatsworth, CA 91311.

- *Air Conditioning Performance Testing.* Chrysler Corporation, M-8671. Available from ASA, P.O. Box 1047, Bedford, TX 76095.

- *Air Conditioning System.* Ford Parts and Service Division, M-8001. Available from ASA, P.O. Box 1047, Bedford, TX 76095.

- *Automotive Air Conditioning Explained.* B-442X. Available from Teaching Aids, Inc., P.O. Box 1798, Costa Mesa, CA 92628.

- *Automotive Air Conditioning Service.* OL, MI-8008V-TTS. Available from Career Aids Division, 20417 Nordhoff St., Dept R 4 5, Chatsworth, CA 91311.

- *The Automotive Air Conditioner.* Set of 3 VHS cassettes. VHS 1, *Basic Parts and Principles* (17:52 min) addresses principles of air conditioning and identifies components and their functions. Demonstrates flow of freon through the system. VHS 2, *Using the Equipment,* (18:00 min) covers major equipment and tools used in air conditioning maintenance and repair; shows procedures for checking pressure, using freon, finding freon leaks. VHS 3, *Troubleshooting Problems,* (14:02 min) shows students how to detect freon leaks, how to troubleshoot, and how to correct problems. Videotapes can be purchased separately. Available from Bergwall Video Productions, Inc., 1-800-645-3565.

- *The Automotive Cooling System.* 406X-V11. Available from Bergwall Video Productions, Inc., P.O. Box 238, Garden City, NY 11530.

- *Basic Air Conditioning Systems.* OL, MI-8010V-TTS. Available from Career Aids Division, 20417 Nordhoff St., Dept. R 4 5, Chatsworth, CA 91311.

- *Discharge and Evaluation.* R-AB138. Available from Teaching Aids, Inc., P.O. Box 1798, Costa Mesa, CA 92628.

- *Draining the Cooling System.* OL, 010-486-TTS. Available from Career Aids Division, 20417 Nordhoff St., Dept. R 4 5, Chatsworth, CA 91311.

- *Heating and Air Conditioning.* Ford Parts and Service Division M-8669. Available from ASA, P.O. Box 1047, Bedford, TX 76095.

- *Keep Your Car Cool.* MO-706. Available from Teaching Aids, Inc., P.O. Box 1798, Costa Mesa, CA 92628.
- *Principles of Climate Control Air Distribution (Car and Light Truck).* ½" VHS, color, (45:56 min). Covers basics of refrigeration and heat transfer. Shows components and discusses functions; covers electrical system as related to heat and air conditioning. Order No: 3640-006A. Available from Ford Service Publications, P.O. Box 07150, Detroit, MI 48207. To place credit card orders, call 1-800-782-4356.
- *Recharge System.* R-AB139. Available from Teaching Aids, Inc., P.O. Box 1798, Costa Mesa, CA 92628.
- *Refilling the Cooling System.* OL. 010-486-TTS. Available from Career Aids Division, 20417 Nordhoff St., Dept R 4 5, Chatsworth, CA 91311.

Publications

- *Auto Heating and Air Conditioning Manual 1989: Motor/Age Professional Mechanic's Edition.* Full coverage for 1987-89 selected domestic cars and light trucks, popular import cars. Order No. 7963. Call Chilton Book Company, School and Library Division, 1-800-345-1214, extension 4729.,
- *Automotive Room Chart Series: Automotive Engine Cooling Systems, Heating, and Air Conditioning.* (27 charts) Enlarged copies of key illustrations in *Automotive Mechanics* by Crouse and Anglin, McGraw-Hill, publisher. Order No. 014545-8. Call 1-800-334-7344.
- *Chilton's Guide to Air Conditioning Repair and Service.* Basic procedures for diagnosis, service, and repair; vacuum and wiring schematics on air conditioning systems in 1982-85 domestic cars, light trucks and popular imports. Order No. ISBN O-8019-s-7580-8. Call Chilton Book Company, School and Library Division, 1-800-345-1214, extension 4729.

UNIT REFERENCES

- *Automotive Air Conditioning.* 014857-0. McGraw-Hill Publishing Company, 1-800-334-7344.
- *Automotive Air Conditioning and Heating.* 0-02-818620-6. Glencoe Publishing Company, 1-800-257-5755.

- Crouse, William H. and Donald L. Anglin. *Automotive Mechanics*. New York, McGraw-Hill Book Company, 1981.
- Dwiggins. *Automotive Air Conditioning*. Delmar Publishers, Inc., 1988.
- Mitchell Information Services, Inc., *Mitchell Automechanics*. New Jersey, Prentice Hall, 1982.

PRETEST ANSWERS

INTRODUCTION TO AIR CONDITIONING

I

EVALUATOR NOTE

Use the following answer key to check student answers to pretest questions. To determine the student's individual study requirements from the pretest results, use the following table, which shows the correlation between the objectives and written pretest questions. Then counsel student individually on pretest results and study requirements.

TABLE

Correlation between objectives and written pretest questions.

Objective	Question
1	1, 2,
2	3, 4, 5
3	6, 7, 8
4	9,
5	10, 11
6	12
7	13, 14, 15, 16
8	17, 18, 19
9	20
10	21, 22, 23, 24, 25, 26

ANSWER KEY

1. c
2. b
3. a
4. c
5. b
6. c
7. a
8. b
9. b
10. c
11. a
12. a
13. c
14. b
15. c
16. a
17. c
18. c
19. b
20. c
21. b
22. c
23. b
24. a
25. c
26. b

PRETEST

INTRODUCTION TO AIR CONDITIONING

I

NAME ____________________ SCORE ______

DIRECTIONS

Read the following questions and problems. Select the item that best answers the question or problem, and write the correct letter in the blank.

OBJECTIVE 1

______1. The high-side of the air conditioning system is the part that ___.

a. is elevated
b. includes the metering device to the compressor inlet
c. includes the compressor outlet to the metering device

______2. The low-side of the air conditioning system is the part that ___.

a. is not elevated
b. includes the metering device to the compressor inlet
c. includes the compressor outlet to the metering device

OBJECTIVE 2

______3. The component of an air conditioner that causes refrigerant to condense, turning it into a liquid is the ___.

a. condenser
b. compressor
c. evaporator

______4. The device that absorbs heat and dehumidifies air in the passenger compartment is the ___.

a. condenser
b. compressor
c. evaporator

______5. The component of an air conditioner that pumps refrigerant through the air conditioning system, raising its temperature is the ___.

a. condenser
b. compressor
c. evaporator

OBJECTIVE 3

______6. Which of the following is true about the process whereby an air conditioner cools air? ___

a. The compressor pumps refrigerant into the evaporator.
b. The condenser pumps refrigerant into the compressor.
c. The compressor pumps refrigerant into the condenser.

______7. Which of the following is true about the process whereby an air conditioner cools air? ___

a. The condenser causes the refrigerant to turn into a liquid.
b. The compressor causes the refrigerant to turn into a liquid.
c. The evaporator causes the refrigerant to turn into a liquid.

______8. Where does the refrigerant boil? ___

a. The condenser
b. The evaporator
c. The compressor

OBJECTIVE 4

______9. Why is one side of the air conditioner called the high-side? ___

a. It is higher in the car.
b. It is under greater pressure.
c. It moves liquid fluid by gravity.

OBJECTIVE 5

_____10. Which of the following contains a receiver/drier? ___

a. An expansion accumulator air conditioner
b. An expansion tube air conditioner
c. An expansion valve air conditioner

_____11. Which of the following contains an accumulator? ___

a. An expansion tube air conditioner
b. An expansion valve air conditioner
c. An expansion accumulator air conditioner

OBJECTIVE 6

_____12. When you are working on an air conditioner, you must always ___.

a. wear eye protection
b. wear a long-sleeve shirt
c. wear safety gloves

OBJECTIVE 7

_____13. Moisture in an air conditioning system ___.

a. causes air to enter the system
b. is good for rapid cooling
c. causes valves to freeze and corrode

_____14. Dirt in an air conditioning system ___.

a. reduces pressure
b. causes acid buildup and clogging
c. causes moisture buildup

_____15. Alcohol in an air conditioning system ___.

a. is good since it is part of the refrigerant
b. causes valves to clog and oil to break down
c. causes refrigerant breakdown, and copper plating, and zinc/aluminum corrosion

_____16. Oil in the air conditioning system ___.

a. is good as long as there is a correct amount
b. causes refrigerant breakdown
c. causes moisture buildup

OBJECTIVE 8

_____17. A manifold gauge is used to check ___.

a. the current refrigerant level
b. system efficiency
c. both a and b

_____18. A flame leak detector is a ___.

a. torch used to seal refrigerant leaks
b. device used to find flammable refrigerant leaks
c. device that uses a flame to detect refrigerant leaks

_____19. An electronic leak detector ___.

a. uses electronics to seal refrigerant leaks
b. uses electronics to find refrigerant leaks
c. detects leaks in the air conditioning electrical systems

OBJECTIVE 9

_____20. When using a manifold gauge, you find that the low side pressure is high and the high-side pressure is low. The most likely cause is that the ___.

a. refrigerant is low
b. system is overcharged
c. compressor is malfunctioning

OBJECTIVE 10

_____21. When checking pressure with the manifold gauge, ___.

a. the low pressure gauge is compared to the high pressure gauge
b. both gauges are compared to the car's normal pressure
c. the low pressure gauge must be half the high pressure gauge

_____22. When using a flame leak detector, ___.

a. light the flame as each leak is detected
b. light the flame after each leak is detected
c. light the flame before beginning

_____23. The electronic leak detector ___.

a. operates on its own power
b. requires a high-voltage outlet
c. requires a normal wall outlet

_____24. When discharging the system, the manifold gauge is ___.

a. connected before the discharge
b. connected after the discharge
c. not used

_____25. When a technician evacuates the system, ___.

a. refrigerant is pumped into the manifold gauge
b. a manifold gauge is not used
c. a vacuum pump is needed

_____26. When charging the system, the refrigerant container is used ___.

a. before the manifold gauge is connected
b. after the manifold gauge is connected
c. either before or after the manifold gauge is connected

INFORMATION SHEET

INTRODUCTION TO AIR CONDITIONING

OBJECTIVE 1

Match terms associated with air conditioning to their definitions.

- **Ambient Temperature** — The outside temperature
- **High-Side** — The part of the air conditioning system in which refrigerant is turning into liquid; includes the compressor outlet to the metering device
- **Low-Side** — The part of the air conditioning system in which refrigerant is turning into gas; includes the metering device to the compressor inlet
- **Recycling Center** — An air conditioning service station that stores refrigerant for recycling and stops it from flowing into the atmosphere
- **Refrigerant** — A chemical that boils at -21.7 degrees Fahrenheit, allowing it to absorb heat easily

OBJECTIVE 2

State the functions of the components of the air conditioning system.

- **Accumulator** — Prevents liquid from entering the compressor
- **Compressor** — Pumps refrigerant through the air conditioning system, raising its temperature
- **Condenser** — Causes refrigerant to condense, turning it into a liquid
- **Evaporator** — A device that absorbs heat and dehumidifies air in the passenger compartment
- **Expansion valve/orifice tube** — A metering device that changes high pressure liquid refrigerant into lower pressure liquid by regulating its flow
- **Receiver/drier** — A device that filters refrigerant

OBJECTIVE 3

Arrange in order the steps of the air conditioning process.

NOTE: The system operates in a circle.

1. The compressor pumps refrigerant into the condenser.
2. The condenser causes the refrigerant to turn into a liquid.
3. The liquid refrigerant flows into the evaporator through a metering device.
4. The refrigerant turns back into gas (boils) in the evaporator as it absorbs heat from the air surrounding the evaporator.
5. The absorption of heat cools air surrounding the evaporator.
6. Cool air is blown into the passenger compartment of the car.
7. The refrigerant flows back into the compressor.

OBJECTIVE 4 **Distinguish between the "high-side" and "low-side" of the air conditioning system.**

High-Side

- Section from the outlet side of the compressor to the metering device.
- Refrigerant is under high pressure.
- Refrigerant is condensed into a liquid.

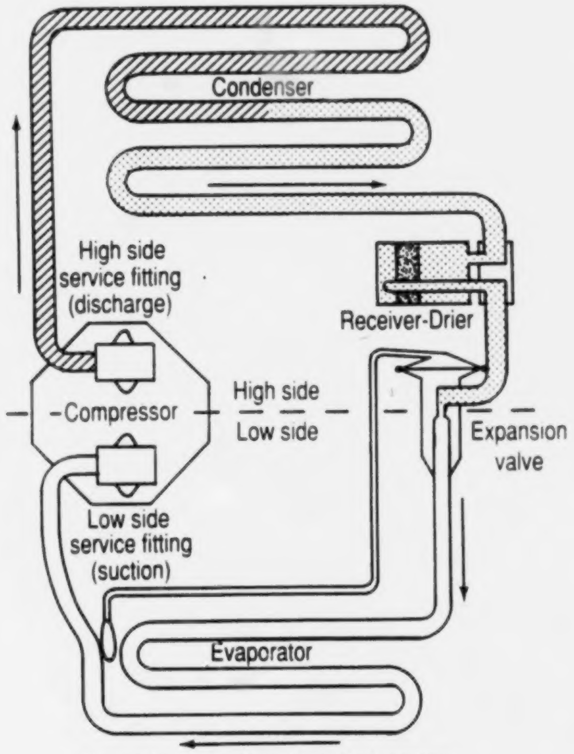
Low-Side

- Section from the metering device to the inlet side of the compressor.
- Refrigerant is under lower pressure.
- Refrigerant is turning into gas.

OBJECTIVE 5 **Label the two main types and parts of the air conditioning system.**

NOTE: There are two types of systems: the expansion valve and the expansion tube. The expansion valve type sends refrigerant to the evaporator through an expansion valve and receiver/drier.

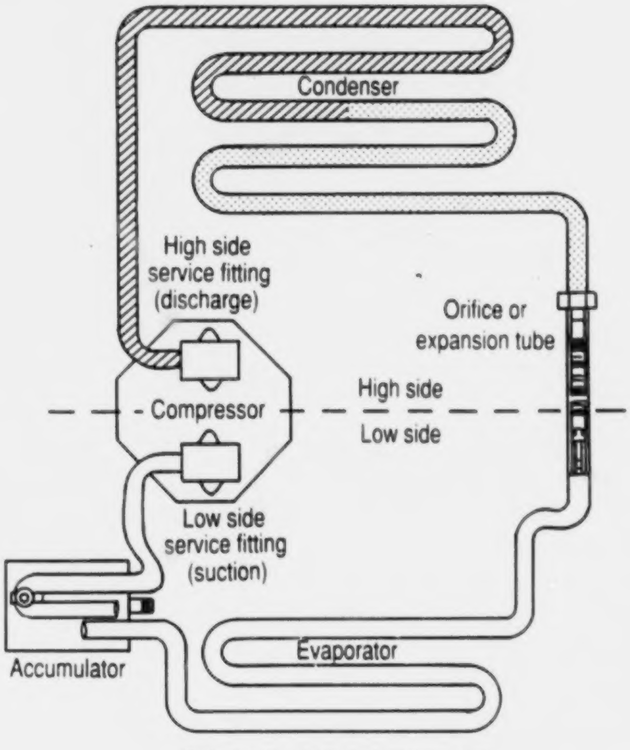
Expansion valve type


Condenser
High side service fitting (discharge)
Receiver-Drier
Compressor
High side
Low side
Expansion valve
Low side service fitting (suction)
Evaporator

Expansion valve (receiver-drier) system

Expansion tube type

NOTE: The expansion tube type air conditioner sends refrigerant to the evaporator through an orifice tube.


Condenser
High side service fitting (discharge)
Orifice or expansion tube
Compressor
High side
Low side
Low side service fitting (suction)
Accumulator
Evaporator

Orifice tube (accumulator) system

OBJECTIVE 6

List safety precautions for working on the air conditioning system.

- Always wear safety goggles when working with refrigerant.
- Never open a high-pressure valve when charging the system with refrigerant when it is operational.

◆ WARNING ◆

The system may explode.

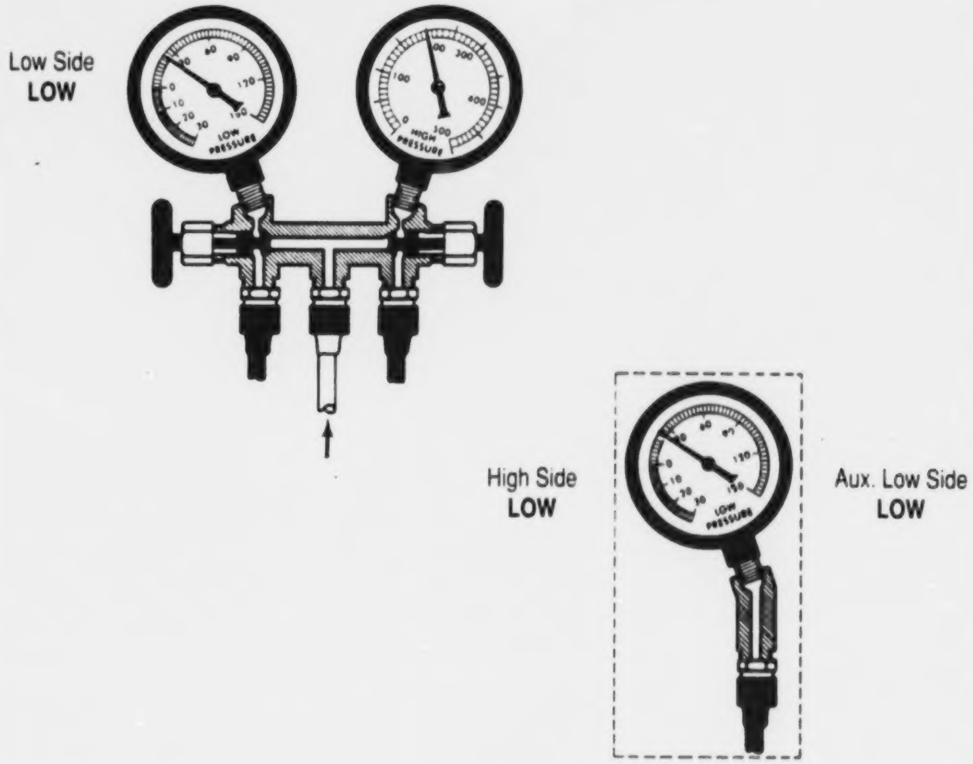
- Wrap a rag around the hose connection before opening it.
- Keep flames away from refrigerant.
- Do not allow refrigerant to come in contact with skin.

OBJECTIVE 7 **Match air conditioning system contaminants to their effects.**

- **Air** — High pressure, moisture buildup, and reduced cooling ability
- **Alcohol** — Refrigerant breakdown, copper plating, and zinc/aluminum corrosion
- **Dirt** — Acid buildup and clogging
- **Dye** — Clogged valves and broken-down oil
- **Incorrect oil** — Excessive wear on moving parts, refrigerant breakdown, and moisture buildup
- **Metal pieces** — Clogged valves and damaged moving parts
- **Moisture** — Frozen valves and corrosion
- **Rubber** — Clogged system

OBJECTIVE 8 **State the functions of air conditioning test equipment.**

- **Manifold gauge** — Used to show the system's high and low side, the current refrigerant level, temperature readiness, system efficiency, and diagnosis

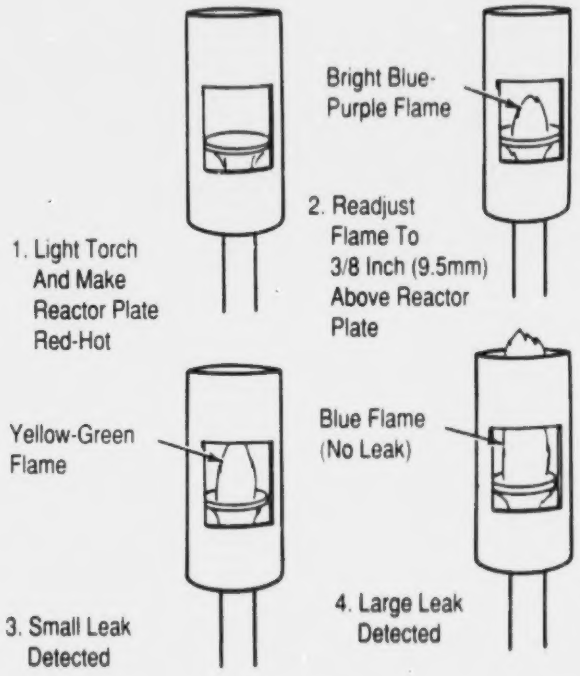

Low Side
LOW
LOW PRESSURE
HIGH PRESSURE
High Side
LOW
Aux. Low Side
LOW
LOW PRESSURE

- **Manifold gauge** — The manifold gauge can be connected to service connectors in the air conditioning system. Reading on the gauges will show the system's high- and low-side, the current refrigerant level, and system efficiency and diagnosis. Almost any problem can be diagnosed using the manifold gauge.

- **Flame leak detector** — Used to check for refrigerant leaks in the system

◆ WARNING ◆

The flame leak detector provides phosgene (a nerve gas). Always use in a well-ventilated area. Never use around the battery.


Bright Blue-Purple Flame
1. Light Torch And Make Reactor Plate Red-Hot
2. Readjust Flame To 3/8 Inch (9.5mm) Above Reactor Plate
Yellow-Green Flame
Blue Flame (No Leak)
3. Small Leak Detected
4. Large Leak Detected

- **Flame leak detector (Halide)** — A flame leak detector is a propane cylinder connected to a hose and reactor plate. The hose is held next to refrigerant hoses and connections. If any leak is detected, a flame will grow larger at the reactor plate. A larger flame means a larger leak.

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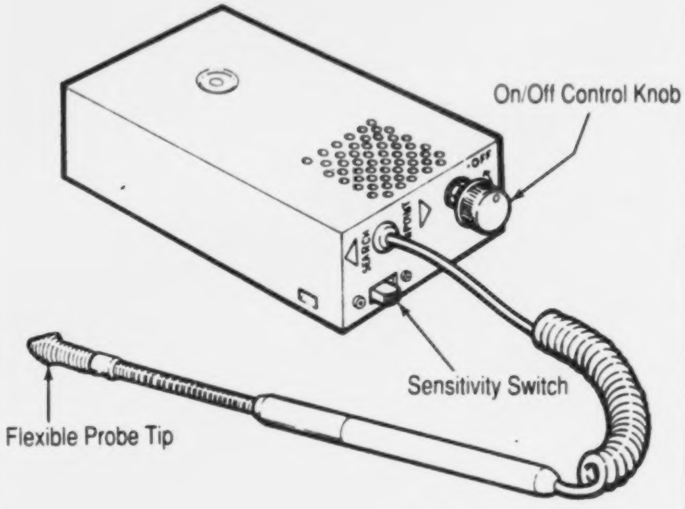
- **Electronic leak detector** — Used to check for refrigerant leaks in the system.

NOTE: This device is preferred to the flame leak detector because it is safer and more sensitive.



- **Electronic leak detector** — An electronic leak detector is a box with a probe connected. The technician moves the probe over the refrigerant hoses and connections. If any leak is detected, a ticking sound will increase. A larger leak will produce a faster ticking sound.

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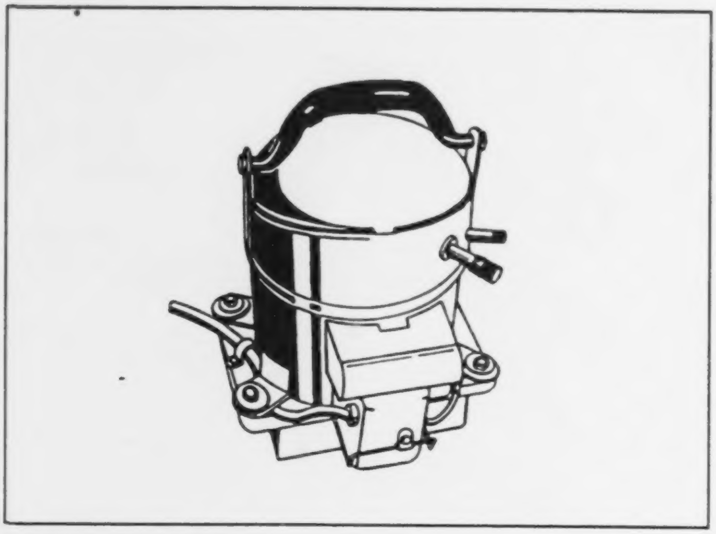
- **Vacuum pump** — A device that removes moisture from refrigerant by lowering the boiling point of water.



NAME ________________________________

CLASS PROJECTS FOR LEARNING ABOUT TYPES OF REFRIGERANT

Find out the difference between the refrigerant used in auto air conditioning and home air conditioning.

R-12, the refrigerant used in auto air conditioning, has certain properties that make it ideal for automobiles. Among them are low operating pressures and stability. See if you can find others.

Find a temperature-pressure chart for R-12, and find the pressure/temperature combinations which make R-12 ideal for auto air conditioning.

As pressure increases, the temperature of R-12 increases. This is how R-12 cools air. Pressure on it decreases, so its temperature decreases.

Find the chemical formula for R-12.

Why is it called R-12? Why is it commonly called freon? How does it affect the ozone layer?

Research the Montreal Protocol.

What did it bring about concerning refrigerant?

ASSIGNMENT SHEET 1

INTRODUCTION TO AIR CONDITIONING

NAME ______________________________ SCORE ________

OBJECTIVE 9 **Interpret a gauge chart.**

INTRODUCTION Many problems can be diagnosed using the manifold gauge. The technician must be familiar with the gauge chart in order to get the most from the manifold gauge.

DIRECTIONS Assume you have just connected the manifold gauge to the system. Using the information given in each question and the gauge chart and ambient temperature chart, identify the proper problem. Write the letter corresponding to the problem in the blank.

NOTE: Different gauge charts apply for different systems. When actually using the manifold gauge, refer to the service manual for the car.

PRESSURE-TEMPERATURE RELATIONSHIP

IF AMBIENT TEMPERATURE IS:	NORMAL LOW SIDE GAUGE READING IS:	NORMAL RANGE FOR HIGH SIDE GAUGE READING IS:
70°F	12 P.S.I.	115-135 P.S.I.
75°F	14 P.S.I.	130-150 P.S.I.
80°F	16 P.S.I.	150-170 P.S.I.
85°F	18 P.S.I.	165-185 P.S.I.
90°F	20 P.S.I.	175-195 P.S.I.
95°F	22 P.S.I.	185-205 P.S.I.
100°F	24 P.S.I.	210-230 P.S.I.
110°F	26 P.S.I.	230-250 P.S.I.
115°F	28 P.S.I.	250-270 P.S.I.
120°F	30 P.S.I.	265-285 P.S.I.

*On systems with STV, POA, EPR valves or VIR assemblies, the low side reading will not vary with temperature. Low-side pressure readings should be 26-32 P.S.I. on POA and STV systems and 22-32 P.S.I. on EPR systems regardless of the ambient temperature.

Ambient temperature

NORMAL OPERATING SYSTEM-FULLY CHARGED

LOW SIDE	HIGH SIDE*	SIGHT GLASS	EVAPORATOR OUTLET	DUCT TEPERATURE
15-30 PSI	150-285 PSI	Clear	Cold	45-55°

NORMAL OPERATING SYSTEM-FULLY CHARGED

LOW SIDE	HIGH SIDE*	SIGHT GLASS	EVAPORATOR OUTLET	DUCT TEMPERATURE
Low	Low	Poor cooling Sight glass foamy or steady bubbles Evaporator outlet warm	Low refrigerant charge	Leak check (system must be 50% charged) Repair leak(s) Normal service
Low or vacuum	Low to Normal	Poor cooling Sight glass clear Evaporator outlet warm	Restriction in high side Note: High side reading may be high if restriction is immediately after service valve	Find restriction Clean or replace expansion valve and screen if clogged Replace receiver-filter-drier Flush system Normal service
Normal to Low	Normal	Warm humid air from ducts Sight glass clear Evaporator outlet cold or iced Continuous compressor operation	Defective thermostatic cycling switch Evaporator freeze-up at low blower or during extended driving	Replace thermostatic cycling switch
High	Low	No cooling Sight glass clear Evaporator outlet warm	Compressor malfunctioning: bad reed valves or bad head gasket	Repair or replace compressor Replace receiver-filter-drier Check expansion valve for contamination Flush system Normal service
Normal to High	High	Fair to poor cooling Sight glass clear or foamy Evaporator outlet cool to warm	System overcharged	Bleed R-12 from the low side in small increments and recheck until gauges return to normal
Normal to High	High	Fair to poor cooling Sight glass clear Evaporator outlet cool to warm	Engine overheating Poor airflow across condenser	Check radiator coolant Check water pump Check fan, fan clutch and fan belts. Replace if necessary. Clean debris from radiator and condenser Straighten condenser fins

Used with permission of Four Seasons, Division of Standard Motor Products.

	Ambient Temperature	Low-Side Reading	High-Side Reading	Problems
1.	85	18	200	__________
2.	120	35	245	__________
3.	80	10	120	__________
4.	90	30	225	__________
5.	70	12	120	__________
6.	100	0	200	__________

a. Low refrigerant charge
b. Restriction in high-side
c. Defective thermostatic cycling switch
d. Evaporator freeze-up
e. Compressor malfunction
f. System overcharge
g. Engine overheating
h. Poor airflow across condenser

ASSIGNMENT ANSWERS

INTRODUCTION TO AIR CONDITIONING I

ASSIGNMENT SHEET 1

1. e
2. e
3. a
4. g
5. c, d
6. b

40

JOB SHEET 1

INTRODUCTION TO AIR CONDITIONING

OBJECTIVE 10a

Perform a system test with a manifold gauge.

TOOLS AND EQUIPMENT

- Proper refrigerant storage container
- Eye protection
- Manifold gauge
- Wrench
- Three pressure hoses
- Service manual

> **CAUTION**
> **ALWAYS** check the procedure in the vehicle's service manual before beginning any service repair.

PROCEDURE

1. Perform a visual check.
2. Be sure the engine is not running.
3. Locate low- and high-side valves and gauges (see service manual).

◆ WARNING ◆

Before proceeding, have your instructor verify your findings.

4. Use the wrench (if needed) to slowly remove protective cap from the low-side service valve.
5. Use the wrench (if needed) to slowly remove protective cap from the high-side service valve.
6. Close both hand valves on the manifold gauge.
7. Connect center hose to proper storage container.
8. Connect the high-side gauge to the high-side service valve using the high-side hose.

NOTE: This connection should be finger-tight.

9. Slightly open the high-side hand valve for 2 seconds, close immediately.

   NOTE: This purges the hoses by allowing refrigerant to flow through them and carry away moisture and dirt.

10. Close high-side hand valve tightly.

11. Connect the low-side gauge to the low-side service valve using the low-side hose.

    NOTE: This connection should be finger-tight.

12. Slightly open the low-side hand valve for 2 seconds, close immediately.

13. Start the engine.

14. Turn the air conditioner to maximum.

15. Turn the fan speed to high.

16. Roll down the windows and close car doors.

17. Wait for 5 minutes.

    NOTE: By allowing the air conditioner to run for 5 minutes, the system becomes stable.

18. Note the high and low pressure and compare them to normal pressure for the make and model of the car.

    NOTE: Normal pressure can be found in the service manual. Differences can be used for diagnostic purposes. Ambient temperature is important when comparing pressure.

19. Wrap a rag around each fitting.

20. Disconnect the low-side hose from the service valve.

21. Disconnect the high-side hose from the service valve.

22. Recap both service valves.

23. Have your instructor check your work.

24. Put away tools and equipment and clean the work area.

JOB SHEET 2

INTRODUCTION TO AIR CONDITIONING

OBJECTIVE 10b

Perform a leak test with a flame leak detector.

TOOLS AND EQUIPMENT

- Eye protection
- Flame leak detector
- Lighter or matches
- Service manual

CAUTION

ALWAYS check the procedure in the vehicle's service manual before beginning any service or repair.

PROCEDURE

1. Perform a visual check of connections and hoses.
2. Open the valve on the flame detector and light it at the reactor plate.

◆ WARNING ◆

Never use the flame detector in closed areas with combustible vapor liquid nearby. Never breathe the fumes from the flame detector.

3. Adjust the flame in the reactor plate to ½ inch.
4. Wait for the reactor to glow.
5. Move the search hose over all hoses and connections in the air conditioning system.

   NOTE: Test for leaks under hoses and fittings since refrigerant settles low.

6. If a leak is detected, the flame will grow and change color.
7. Note the location of any leaks.
8. Close the valve on the leak detector.
9. Report leaks to your instructor.
10. Put away tools and equipment and clean the work area.

JOB SHEET 3

INTRODUCTION TO AIR CONDITIONING

OBJECTIVE 10c

Perform a leak test with an electronic leak detector.

NOTE: The electronic leak detector is more sensitive than the flame leak detector.

TOOLS AND EQUIPMENT

- Eye protection
- Manual for leak detector
- Electronic leak detector
- Service manual

> **CAUTION**
> **ALWAYS** check the procedure in the vehicle's service manual before beginning any service or repair.

PROCEDURE

1. Perform a visual check of hoses and connections.
2. Turn on leak detector.
3. Let the leak detector stabilize for about 30 seconds.
4. Make adjustments.

   NOTE: Refer to the electronic leak detector manual for exact time and operation procedure.

5. Turn the sensitivity switch to SEARCH.
6. Move the search probe UNDER all connections and hoses.

   NOTE: Refrigerant is heavier than air, so the probe must be kept lower than the connections and hoses.

7. When a leak is detected, the leak detector will tick faster.
8. Note the location of any leaks.
9. Turn off the leak detector.
10. Report leaks to your instructor.
11. Put away tools and equipment and clean the work area.

JOB SHEET 4

INTRODUCTION TO AIR CONDITIONING

I

OBJECTIVE 10d

Discharge the system.

NOTE: This is done in order to work on components or change oil.

TOOLS AND EQUIPMENT

- Proper refrigerant storage container
- Eye protection
- Manifold gauge
- Wrenches
- Three pressure hoses
- Service manual

> **CAUTION**
> **ALWAYS** check the procedure in the vehicle's service manual before beginning any service or repair.

PROCEDURE

1. Perform a visual inspection.
2. Connect the manifold gauge to the system. (See Job Sheet 1.)
3. Close all hand valves on the manifold gauge.
4. Connect the other end of the center pressure hose to storage container.
5. Slowly open the low-side hand valve on the manifold gauge.

CAUTION

Do not open the hand valve too slowly or the system will lose oil.

6. Slowly open the high-side hand valve in order to relieve all pressure.
7. Wait until the pressure gauges on the manifold gauge read zero.
8. Close all hand valves on the manifold gauge.
9. Disconnect manifold gauge from system. (See Job Sheet 1.)

10. Have your instructor check your work.

11. Put away tools and equipment and clean the work area.

JOB
SHEET 5

INTRODUCTION TO AIR CONDITIONING

I

OBJECTIVE 10e

Use a refrigerant recycling center.

TOOLS AND EQUIPMENT

- Eye protection
- Refrigerant recycling center
- Refrigerant recycling center operation manual
- Service manual

PROCEDURE

1. Connect the recycling center to the air conditioning system as outlined in the operation manual.
2. Discharge, evacuate, and/or charge the system as outlined in the recycling center operation manual.
3. Disconnect the recycling center from the air conditioning system as outlined in the operation manual.
4. Have your instructor check your work.
5. Put away tools and equipment and clean the work area.

JOB SHEET 6 INTRODUCTION TO AIR CONDITIONING

OBJECTIVE 10f **Inspect the A/C oil level.**

TOOLS AND EQUIPMENT

- Eye protection
- Wrenches
- Oil dipstick (See service manual.)
- Service manual

> **CAUTION**
> **ALWAYS** check the procedure in the vehicle's service manual before beginning any service or repair.

PROCEDURE

1. Perform a visual inspection. Look for oil on fittings.
2. Discharge the system. (See Job Sheet 4.)
3. Remove the oil plug from the compressor if equipped.
4. Use the dipstick to measure oil level.
5. Compare the measured amount to the compressor's requirements. (See service manual for correct amount.)
6. Replace oil plug.
7. Charge the system. (See Job Sheet 8.)
8. Report the difference (if any) to your instructor.
9. Put away tools and equipment and clean the work area.

OBJECTIVE 10g

Evacuate the system.

NOTE: This is done in order to eliminate all air and moisture in the system.

TOOLS AND EQUIPMENT

- Eye protection
- Wrench
- Manifold gauge
- Three pressure hoses
- Vacuum pump with manual
- Service manual

> **CAUTION**
> **ALWAYS** check the procedure in the vehicle's service manual before beginning any service or repair.

PROCEDURE

1. Perform a visual inspection.
2. Connect the manifold gauge to the system. (See Job Sheet 1.)
3. Discharge the system. (See Job Sheet 4.)
4. Check vacuum pump manual for proper servicing procedures if required.
5. Close all manifold hand valves.
6. Use the wrench (if needed) to take off the caps to the inlet and exhaust ports on the vacuum pump.
7. Connect the center hose of the manifold gauge to the vacuum pump inlet port.
8. Turn on the vacuum pump.
9. Open the high- and low-side hand valves on the manifold gauge.
10. Watch the pressure gauges on the manifold gauge. They should begin to drop.

11. Pump until the low-side pressure gauge reads 26 to 30 inches.

12. Close the high- and low-side hand valve on the manifold gauge.

13. Turn off the vacuum pump.

14. Wait 2-5 minutes to perform system leak-down test.

15. Continue pumping for a minimum of 30 minutes by performing steps 5-10.

16. Disconnect the vacuum pump from the manifold gauge.

17. Reconnect caps to the inlet and exhaust ports on the vacuum pump.

18. Have your instructor check your work.

19. Put away tools and equipment and clean the work area.

JOB SHEET 8 INTRODUCTION TO AIR CONDITIONING

I

OBJECTIVE 10h

Charge the system.

NOTE: This is done after working on the system. If the system was discharged, a purge must be performed first.

TOOLS AND EQUIPMENT

- Eye protection
- Wrench
- Manifold gauge
- Three pressure hoses
- Refrigerant as needed
- Service manual
- Can tap and charging cylinder or bulk refrigerant
- Refrigerant oil
- Vacuum pump

> **CAUTION**
> **ALWAYS** check the procedure in the vehicle's service manual before beginning any service or repair.

PROCEDURE

1. Perform a visual inspection.
2. Connect the manifold gauge to the system. (See Job Sheet 1.)
3. Close both hand valves on the manifold gauge.
4. Attach vacuum pump and pump the system. (See Job Sheet 7.)
5. Close both hand valves on the manifold gauge.
6. Disconnect vacuum pump. (See Job Sheet 7.)
7. Note the weight of bulk container or number of ounces in each charging cylinder.
8. Connect refrigerant can to center hose on manifold gauge.

   NOTE: Refer to instructor when connecting or disconnecting cans.

9. Open the low-side hand valve on the manifold gauge.

10. Hold the refrigerant can upright to allow refrigerant vapor to flow into system.

    NOTE: Place can in luke-warm tap water to assist in vaporization of refrigerant.

11. Start engine.

12. Watch the pressure on the manifold gauge. Fill with refrigerant until determined amount has been dispersed. (See service manual for specifications.)

13. When the system is full, close the low-side hand valve on the manifold gauge.

14. Remove the refrigerant can or shut off valve on bulk container.

    NOTE: Refer to instructor when removing can.

15. Disconnect the manifold gauge. (See Job Sheet 1.)

16. Reconnect protective caps on service valves.

17. Have your instructor check your work.

18. Put away tools and equipment and clean the work area.

JOB SHEET 9

INTRODUCTION TO AIR CONDITIONING

OBJECTIVE 10i **Use a charging station.**

TOOLS AND EQUIPMENT

- Eye protection
- Charging station
- Charging station operation manual
- Service manual

PROCEDURE

1. Connect the charging station to the air conditioning system as outlined in the operation manual.
2. Discharge, evacuate, and/or charge the system as outlined in the charging station operation manual.
3. Disconnect the charging station from the air conditioning system as outlined in the operation manual.
4. Have your instructor check your work.
5. Put away tools and equipment and clean the work area.

PRACTICAL TEST 1

INTRODUCTION TO AIR CONDITIONING

JOB SHEET 1

Perform a system test with a manifold gauge.

STUDENT'S NAME ____________________ DATE ______________

EVALUATOR'S NAME __________________ ATTEMPT NO. _____

INSTRUCTIONS

When you are ready to perform this task, ask your instructor to observe the procedure and complete this form. All items listed under "Process Evaluation" must receive a "Yes" for you to receive an acceptable performance evaluation.

PROCESS EVALUATION

Evaluator Note: Place a check mark in the "Yes" or "No" blanks to designate whether or not the student has satisfactorily achieved each step in this procedure. If the student is unable to achieve this competency, have the student review the materials and try again.

The student	YES	NO
1. Performed a visual check.	_____	_____
2. Made sure the engine was not running.	_____	_____
3. Located valves and gauges.	_____	_____
4. Removed protective cap from the low-side service valve.	_____	_____
5. Removed protective cap from the high-side service valve.	_____	_____
6. Closed both hand valves on the manifold gauge.	_____	_____
7. Connected hose to storage container.	_____	_____
8. Connected the high-side gauge to the high-side service valve.	_____	_____
9. Slightly opened the high-side hand valve for 2 seconds. Closed it immediately.	_____	_____
10. Closed high-side hand valves tightly.	_____	_____

	YES	NO
11. Connected the low-side gauge to the low-side service valve.	_____	_____
12. Opened the low-side hand valve for 2 seconds.	_____	_____
13. Started the engine.	_____	_____
14. Turned the air conditioner to maximum.	_____	_____
15. Turned the fan speed to high.	_____	_____
16. Rolled down the windows and closed car doors.	_____	_____
17. Waited for 5 minutes.	_____	_____
18. Noted the high and low pressure and compared them to normal pressure for car.	_____	_____
19. Wrapped a rag around each fitting.	_____	_____
20. Disconnected the low-side hose from the service valve.	_____	_____
21. Disconnected the high-side hose from the service valve.	_____	_____
22. Recapped both service valves.	_____	_____
23. Reported to instructor.	_____	_____
24. Used proper tools correctly.	_____	_____
25. Performed steps in a timely manner.	_____	_____
26. Practiced safety rules throughout procedure.	_____	_____
27. Provided satisfactory responses to questions asked.	_____	_____

	YES	NO
28. Put away tools and equipment and cleaned work area.	____	____

EVALUATOR'S COMMENTS

PRODUCT EVALUATION

Evaluator Note: Rate the student on the following criteria by circling the appropriate numbers. Each criterion must receive a rating of "3" or higher to demonstrate student mastery. (See performance evaluation key.) A student who is unable to demonstrate mastery should review the materials and submit another product for evaluation.

Criteria				
Product meets manufacturer's installation specifications.	4	3	2	1
Product meets manufacturer's adjustment specifications.	4	3	2	1
Product includes proper components/materials.	4	3	2	1
Product appearance meets industry standards.	4	3	2	1

EVALUATOR'S COMMENTS

____

____

____

AVERAGE RATING

Evaluator Note: To obtain an average rating for the competency profile, total the designated points in "Product Evaluation" and divide by the total number of criteria. Circle the rating on the "Performance Evaluation Key" below.

PERFORMANCE EVALUATION KEY

4 — Skilled — Can perform job with no additional training.
3 — Moderately skilled — Has performed job during training program; limited additional training may be required.
2 — Limited skill — Has performed job during training program; additional training is required to develop skill.
1 — Unskilled — Is familiar with process, but is unable to perform job.

JOB SHEET 2

Perform a leak test with a flame leak detector.

STUDENT'S NAME ____________________ DATE ______________

EVALUATOR'S NAME ________________ ATTEMPT NO. _____

INSTRUCTIONS

When you are ready to perform this task, ask your instructor to observe the procedure and complete this form. All items listed under "Process Evaluation" must receive a "Yes" for you to receive an acceptable performance evaluation.

PROCESS EVALUATION

Evaluator Note: Place a check mark in the "Yes" or "No" blanks to designate whether or not the student has satisfactorily achieved each step in this procedure. If the student is unable to achieve this competency, have the student review the materials and try again.

The student	YES	NO
1. Performed a visual check.	_____	_____
2. Opened the valve on the flame detector and lit it at the reactor plate.	_____	_____
3. Adjusted the flame in the reactor plate to ½ inch.	_____	_____
4. Waited for the reactor plate to glow.	_____	_____
5. Moved the search hose over all hoses and connections in the air conditioning system.	_____	_____
6. Noted the location of any leaks.	_____	_____
7. Closed the valve on the leak detector.	_____	_____
8. Reported leaks to instructor.	_____	_____
9. Used proper tools correctly.	_____	_____
10. Performed steps in a timely manner.	_____	_____

	YES	NO
11. Practiced safety rules throughout procedure.	____	____
12. Provided satisfactory responses to questions asked.	____	____
13. Put away tools and equipment and cleaned work area.	____	____

EVALUATOR'S COMMENTS

PRODUCT EVALUATION

Evaluator Note: Rate the student on the following criteria by circling the appropriate numbers. Each criterion must receive a rating of "3" or higher to demonstrate student mastery. (See performance evaluation key.) A student who is unable to demonstrate mastery should review the materials and submit another product for evaluation.

Criteria				
Product meets manufacturer's installation specifications.	4	3	2	1
Product meets manufacturer's adjustment specifications.	4	3	2	1
Product includes proper components/materials.	4	3	2	1
Product appearance meets industry standards.	4	3	2	1

EVALUATOR'S COMMENTS

AVERAGE RATING

Evaluator Note: To obtain an average rating for the competency profile, total the designated points in "Product Evaluation" and divide by the total number of criteria. Circle the rating on the "Performance Evaluation Key" below.

PERFORMANCE EVALUATION KEY

4 — Skilled — Can perform job with no additional training.
3 — Moderately skilled — Has performed job during training program; limited additional training may be required.
2 — Limited skill — Has performed job during training program; additional training is required to develop skill.
1 — Unskilled — Is familiar with process, but is unable to perform job.

PRACTICAL TEST 3

INTRODUCTION TO AIR CONDITIONING

JOB SHEET 3

Perform a leak test with an electronic leak detector.

STUDENT'S NAME ____________________ DATE ______________

EVALUATOR'S NAME __________________ ATTEMPT NO. ______

INSTRUCTIONS

When you are ready to perform this task, ask your instructor to observe the procedure and complete this form. All items listed under "Process Evaluation" must receive a "Yes" for you to receive an acceptable performance evaluation.

PROCESS EVALUATION

Evaluator Note: Place a check mark in the "Yes" or "No" blanks to designate whether or not the student has satisfactorily achieved each step in this procedure. If the student is unable to achieve this competency, have the student review the materials and try again.

The student	YES	NO
1. Performed a visual check.	_____	_____
2. Turned on leak detector.	_____	_____
3. Let the leak detector warm up for about 30 seconds.	_____	_____
4. Made adjustments.	_____	_____
5. Turned the sensitivity switch to SEARCH.	_____	_____
6. Moved the search probe UNDER all connections and hoses.	_____	_____
7. Noted the location of any leaks.	_____	_____
8. Turned off the leak detector.	_____	_____
9. Reported leaks to instructor.	_____	_____
10. Used proper tools correctly.	_____	_____
11. Performed steps in a timely manner.	_____	_____

	YES	NO
12. Practiced safety rules throughout procedure.	____	____
13. Provided satisfactory responses to questions asked.	____	____
14. Put away tools and equipment and cleaned work area.	____	____

EVALUATOR'S COMMENTS ____

____

PRODUCT EVALUATION

Evaluator Note: Rate the student on the following criteria by circling the appropriate numbers. Each criterion must receive a rating of "3" or higher to demonstrate student mastery. (See performance evaluation key.) A student who is unable to demonstrate mastery should review the materials and submit another product for evaluation.

Criteria				
Product meets manufacturer's installation specifications.	4	3	2	1
Product meets manufacturer's adjustment specifications.	4	3	2	1
Product includes proper components/materials.	4	3	2	1
Product appearance meets industry standards.	4	3	2	1

EVALUATOR'S COMMENTS

____

____

____

AVERAGE RATING

Evaluator Note: To obtain an average rating for the competency profile, total the designated points in "Product Evaluation" and divide by the total number of criteria. Circle the rating on the "Performance Evaluation Key" below.

PERFORMANCE EVALUATION KEY

4 — Skilled — Can perform job with no additional training.
3 — Moderately skilled — Has performed job during training program; limited additional training may be required.
2 — Limited skill — Has performed job during training program; additional training is required to develop skill.
1 — Unskilled — Is familiar with process, but is unable to perform job.

PRACTICAL TEST 4

INTRODUCTION TO AIR CONDITIONING

JOB SHEET 4

Discharge the system.

STUDENT'S NAME ____________________ DATE __________

EVALUATOR'S NAME ____________________ ATTEMPT NO. ______

INSTRUCTIONS

When you are ready to perform this task, ask your instructor to observe the procedure and complete this form. All items listed under "Process Evaluation" must receive a "Yes" for you to receive an acceptable performance evaluation.

PROCESS EVALUATION

Evaluator Note: Place a check mark in the "Yes" or "No" blanks to designate whether or not the student has satisfactorily achieved each step in this procedure. If the student is unable to achieve this competency, have the student review the materials and try again.

The student	YES	NO
1. Performed a visual check.	_____	_____
2. Connected the manifold gauge to the system.	_____	_____
3. Closed all hand valves on the manifold gauge.	_____	_____
4. Connected the other end of the center pressure hose to storage container.	_____	_____
5. Slowly opened the low-side hand valve on the manifold gauge.	_____	_____
6. Slowly opened high-side hand valve.	_____	_____
7. Waited until the pressure gauges on the manifold gauge read zero.	_____	_____
8. Closed all hand valves on the manifold gauge.	_____	_____
9. Disconnected manifold gauge from system.	_____	_____

	YES	NO
10. Reported to instructor.	_____	_____
11. Used proper tools correctly.	_____	_____
12. Performed steps in a timely manner.	_____	_____
13. Practiced safety rules throughout procedure.	_____	_____
14. Provided satisfactory responses to questions asked.	_____	_____
15. Put away tools and equipment and cleaned work area.	_____	_____

EVALUATOR'S COMMENTS ____

____

PRODUCT EVALUATION

Evaluator Note: Rate the student on the following criteria by circling the appropriate numbers. Each criterion must receive a rating of "3" or higher to demonstrate student mastery. (See performance evaluation key.) A student who is unable to demonstrate mastery should review the materials and submit another product for evaluation.

Criteria				
Product meets manufacturer's installation specifications.	4	3	2	1
Product meets manufacturer's adjustment specifications.	4	3	2	1
Product includes proper components/materials.	4	3	2	1
Product appearance meets industry standards.	4	3	2	1

EVALUATOR'S COMMENTS

AVERAGE RATING

Evaluator Note: To obtain an average rating for the competency profile, total the designated points in "Product Evaluation" and divide by the total number of criteria. Circle the rating on the "Performance Evaluation Key" below.

PERFORMANCE EVALUATION KEY

4 — Skilled — Can perform job with no additional training.
3 — Moderately skilled — Has performed job during training program; limited additional training may be required.
2 — Limited skill — Has performed job during training program; additional training is required to develop skill.
1 — Unskilled — Is familiar with process, but is unable to perform job.

PRACTICAL TEST 5

INTRODUCTION TO AIR CONDITIONING

I

JOB SHEET 5

Use a refrigerant recycling center.

STUDENT'S NAME ____________________ DATE ______________

EVALUATOR'S NAME __________________ ATTEMPT NO. _____

INSTRUCTIONS

When you are ready to perform this task, ask your instructor to observe the procedure and complete this form. All items listed under "Process Evaluation" must receive a "Yes" for you to receive an acceptable performance evaluation.

PROCESS EVALUATION

Evaluator Note: Place a check mark in the "Yes" or "No" blanks to designate whether or not the student has satisfactorily achieved each step in this procedure. If the student is unable to achieve this competency, have the student review the materials and try again.

The student	YES	NO
1. Connected the recycling center to the air conditioning system as outlined in the operation manual.	_____	_____
2. Discharged, evacuated, and/or charged the system as outlined in the recycling center operation manual.	_____	_____
3. Disconnected the recycling center from the air conditioning system as outlined in the operation manual.	_____	_____
4. Used proper tools correctly.	_____	_____
5. Performed steps in a timely manner.	_____	_____
6. Practiced safety rules throughout procedure.	_____	_____
7. Provided satisfactory responses to questions asked.	_____	_____
8. Put away tools and equipment and cleaned work area.	_____	_____

EVALUATOR'S COMMENTS

PRODUCT EVALUATION

Evaluator Note: Rate the student on the following criteria by circling the appropriate numbers. Each criterion must receive a rating of "3" or higher to demonstrate student mastery. (See performance evaluation key.) A student who is unable to demonstrate mastery should review the materials and submit another product for evaluation.

Criteria				
Product meets manufacturer's installation specifications.	4	3	2	1
Product meets manufacturer's adjustment specifications.	4	3	2	1
Product includes proper components/materials.	4	3	2	1
Product appearance meets industry standards.	4	3	2	1

EVALUATOR'S COMMENTS

AVERAGE RATING

Evaluator Note: To obtain an average rating for the competency profile, total the designated points in "Product Evaluation" and divide by the total number of criteria. Circle the rating on the "Performance Evaluation Key" below.

PERFORMANCE EVALUATION KEY

4 — Skilled — Can perform job with no additional training.
3 — Moderately skilled — Has performed job during training program; limited additional training may be required.
2 — Limited skill — Has performed job during training program; additional training is required to develop skill.
1 — Unskilled — Is familiar with process, but is unable to perform job.

PRACTICAL TEST 6

INTRODUCTION TO AIR CONDITIONING

I

JOB SHEET 6

Inspect the A/C oil.

STUDENT'S NAME ____________________ DATE ______________

EVALUATOR'S NAME ____________________ ATTEMPT NO. ______

INSTRUCTIONS

When you are ready to perform this task, ask your instructor to observe the procedure and complete this form. All items listed under "Process Evaluation" must receive a "Yes" for you to receive an acceptable performance evaluation.

PROCESS EVALUATION

Evaluator Note: Place a check mark in the "Yes" or "No" blanks to designate whether or not the student has satisfactorily achieved each step in this procedure. If the student is unable to achieve this competency, have the student review the materials and try again.

The student	YES	NO
1. Performed visual check.	_____	_____
2. Discharged the system.	_____	_____
3. Removed the oil plug from the compressor.	_____	_____
4. Used the dipstick to measure oil level.	_____	_____
5. Compared the measured amount to the compressor's requirements.	_____	_____
6. Replaced oil plug.	_____	_____
7. Charged the system.	_____	_____
8. Reported to instructor.	_____	_____
9. Used proper tools correctly.	_____	_____
10. Performed steps in a timely manner.	_____	_____
11. Practiced safety rules throughout procedure.	_____	_____

	YES	NO
12. Provided satisfactory responses to questions asked.	_____	_____
13. Put away tools and equipment and cleaned work area.	_____	_____

EVALUATOR'S COMMENTS

____

____

PRACTICAL TEST 6

INTRODUCTION TO AIR CONDITIONING

I

JOB SHEET 6

Inspect the A/C oil.

STUDENT'S NAME ____________________ DATE ______________

EVALUATOR'S NAME __________________ ATTEMPT NO. ______

INSTRUCTIONS

When you are ready to perform this task, ask your instructor to observe the procedure and complete this form. All items listed under "Process Evaluation" must receive a "Yes" for you to receive an acceptable performance evaluation.

PROCESS EVALUATION

Evaluator Note: Place a check mark in the "Yes" or "No" blanks to designate whether or not the student has satisfactorily achieved each step in this procedure. If the student is unable to achieve this competency, have the student review the materials and try again.

The student	YES	NO
1. Performed visual check.	_____	_____
2. Discharged the system.	_____	_____
3. Removed the oil plug from the compressor.	_____	_____
4. Used the dipstick to measure oil level.	_____	_____
5. Compared the measured amount to the compressor's requirements.	_____	_____
6. Replaced oil plug.	_____	_____
7. Charged the system.	_____	_____
8. Reported to instructor. .	_____	_____
9. Used proper tools correctly.	_____	_____
10. Performed steps in a timely manner.	_____	_____
11. Practiced safety rules throughout procedure.	_____	_____

	YES	NO
12. Provided satisfactory responses to questions asked.	____	____
13. Put away tools and equipment and cleaned work area.	____	____

EVALUATOR'S COMMENTS

____

____

PRODUCT EVALUATION

Evaluator Note: Rate the student on the following criteria by circling the appropriate numbers. Each criterion must receive a rating of "3" or higher to demonstrate student mastery. (See performance evaluation key.) A student who is unable to demonstrate mastery should review the materials and submit another product for evaluation.

Criteria				
Product meets manufacturer's installation specifications.	4	3	2	1
Product meets manufacturer's adjustment specifications.	4	3	2	1
Product includes proper components/materials.	4	3	2	1
Product appearance meets industry standards.	4	3	2	1

EVALUATOR'S COMMENTS

AVERAGE RATING

Evaluator Note: To obtain an average rating for the competency profile, total the designated points in "Product Evaluation" and divide by the total number of criteria. Circle the rating on the "Performance Evaluation Key" below.

PERFORMANCE EVALUATION KEY

4 — Skilled — Can perform job with no additional training.
3 — Moderately skilled — Has performed job during training program; limited additional training may be required.
2 — Limited skill — Has performed job during training program; additional training is required to develop skill.
1 — Unskilled — Is familiar with process, but is unable to perform job.

PRACTICAL TEST 7

INTRODUCTION TO AIR CONDITIONING

I

JOB SHEET 7

Evacuate the system.

STUDENT'S NAME ______________________ DATE ______________

EVALUATOR'S NAME ___________________ ATTEMPT NO. ______

INSTRUCTIONS

When you are ready to perform this task, ask your instructor to observe the procedure and complete this form. All items listed under "Process Evaluation" must receive a "Yes" for you to receive an acceptable performance evaluation.

PROCESS EVALUATION

Evaluator Note: Place a check mark in the "Yes" or "No" blanks to designate whether or not the student has satisfactorily achieved each step in this procedure. If the student is unable to achieve this competency, have the student review the materials and try again.

The student	YES	NO
1. Performed a visual check.	_____	_____
2. Connected the manifold gauge to the system.	_____	_____
3. Discharged the system.	_____	_____
4. Performed vacuum pump servicing.	_____	_____
5. Closed all manifold hand valves.	_____	_____
6. Took-off the caps to the inlet and exhaust ports on the vacuum pump.	_____	_____
7. Connected the center hose of the manifold gauge to the vacuum pump inlet port.	_____	_____
8. Turned on the vacuum pump.	_____	_____
9. Opened the high- and low-side hand valves on the manifold gauge.	_____	_____

		YES	NO
10.	Watched the pressure gauges on the manifold gauge.	____	____
11.	Pumped until the low-side pressure gauge read 26-30 inches.	____	____
12.	Closed the high- and low-side hand valve on the manifold gauge.	____	____
13.	Turned off the vacuum pump.	____	____
14.	Waited 2-5 minutes.	____	____
15.	Pumped another 30 minutes.	____	____
16.	Disconnected the vacuum pump from the manifold gauge.	____	____
17.	Reconnected caps to the inlet and exhaust ports on the vacuum pump.	____	____
18.	Reported to instructor.	____	____
19.	Used proper tools correctly.	____	____
20.	Performed steps in a timely manner.	____	____
21.	Practiced safety rules throughout procedure.	____	____
22.	Provided satisfactory responses to questions asked.	____	____
23.	Put away tools and equipment and cleaned work area.	____	____

EVALUATOR'S COMMENTS ____

____

PRODUCT EVALUATION

Evaluator Note: Rate the student on the following criteria by circling the appropriate numbers. Each criterion must receive a rating of "3" or higher to demonstrate student mastery. (See performance evaluation key.) A student who is unable to demonstrate mastery should review the materials and submit another product for evaluation.

Criteria				
Product meets manufacturer's installation specifications.	4	3	2	1
Product meets manufacturer's adjustment specifications.	4	3	2	1
Product includes proper components/materials.	4	3	2	1
Product appearance meets industry standards.	4	3	2	1

EVALUATOR'S COMMENTS

____

____

____

AVERAGE RATING

Evaluator Note: To obtain an average rating for the competency profile, total the designated points in "Product Evaluation" and divide by the total number of criteria. Circle the rating on the "Performance Evaluation Key" below.

PERFORMANCE EVALUATION KEY

4 — Skilled — Can perform job with no additional training.
3 — Moderately skilled — Has performed job during training program; limited additional training may be required.
2 — Limited skill — Has performed job during training program; additional training is required to develop skill.
1 — Unskilled — Is familiar with process, but is unable to perform job.

PRACTICAL TEST 8

INTRODUCTION TO AIR CONDITIONING

I

JOB SHEET 8

Charge the system.

STUDENT'S NAME ____________________ DATE ____________

EVALUATOR'S NAME ____________________ ATTEMPT NO. ______

INSTRUCTIONS

When you are ready to perform this task, ask your instructor to observe the procedure and complete this form. All items listed under "Process Evaluation" must receive a "Yes" for you to receive an acceptable performance evaluation.

PROCESS EVALUATION

Evaluator Note: Place a check mark in the "Yes" or "No" blanks to designate whether or not the student has satisfactorily achieved each step in this procedure. If the student is unable to achieve this competency, have the student review the materials and try again.

The student	YES	NO
1. Performed a visual check.	_____	_____
2. Connected the manifold gauge to the system.	_____	_____
3. Closed both hand valves on the manifold gauge.	_____	_____
4. Attached vacuum pump.	_____	_____
5. Pumped the system.	_____	_____
6. Closed both hand valves on the manifold gauge.	_____	_____
7. Disconnected vacuum pump.	_____	_____
8. Connected refrigerant can to center hose on manifold gauge.	_____	_____
9. Opened the low-side hand valve on the manifold gauge.	_____	_____
10. Held the refrigerant can upright.	_____	_____

	YES	NO
11. Started engine.	____	____
12. Watched the pressure on the manifold gauge.	____	____
13. When the system was full, closed the low-side hand valve on the manifold gauge.	____	____
14. Removed the refrigerant can.	____	____
15. Disconnected the manifold gauge.	____	____
16. Reconnect protective caps on service valves.	____	____
17. Reported to instructor.	____	____
18. Used proper tools correctly.	____	____
19. Performed steps in a timely manner.	____	____
20. Practiced safety rules throughout procedure.	____	____
21. Provided satisfactory responses to questions asked.	____	____
22. Put away tools and equipment and cleaned work area.	____	____

EVALUATOR'S COMMENTS ____

____

PRODUCT EVALUATION

Evaluator Note: Rate the student on the following criteria by circling the appropriate numbers. Each criterion must receive a rating of "3" or higher to demonstrate student mastery. (See performance evaluation key.) A student who is unable to demonstrate mastery should review the materials and submit another product for evaluation.

Criteria				
Product meets manufacturer's installation specifications.	4	3	2	1
Product meets manufacturer's adjustment specifications.	4	3	2	1
Product includes proper components/materials.	4	3	2	1
Product appearance meets industry standards.	4	3	2	1

EVALUATOR'S COMMENTS

AVERAGE RATING

Evaluator Note: To obtain an average rating for the competency profile, total the designated points in "Product Evaluation" and divide by the total number of criteria. Circle the rating on the "Performance Evaluation Key" below.

PERFORMANCE EVALUATION KEY

4 — Skilled — Can perform job with no additional training.
3 — Moderately skilled — Has performed job during training program; limited additional training may be required.
2 — Limited skill — Has performed job during training program; additional training is required to develop skill.
1 — Unskilled — Is familiar with process, but is unable to perform job.

PRACTICAL TEST 9

INTRODUCTION TO AIR CONDITIONING

JOB SHEET 9

Use a charging station.

STUDENT'S NAME ____________ DATE ________

EVALUATOR'S NAME ____________ ATTEMPT NO. ____

INSTRUCTIONS

When you are ready to perform this task, ask your instructor to observe the procedure and complete this form. All items listed under "Process Evaluation" must receive a "Yes" for you to receive an acceptable performance evaluation.

PROCESS EVALUATION

Evaluator Note: Place a check mark in the "Yes" or "No" blanks to designate whether or not the student has satisfactorily achieved each step in this procedure. If the student is unable to achieve this competency, have the student review the materials and try again.

The student	YES	NO
1. Connected the charging station to the air conditioning system as outlined in the operation manual.	____	____
2. Discharged, evacuated, and/or charged the system as outlined in the charging station operation manual.	____	____
3. Disconnected the charging station from the air conditioning system as outlined in the operation manual.	____	____
4. Used proper tools correctly.	____	____
5. Performed steps in a timely manner.	____	____
6. Practiced safety rules throughout procedure.	____	____
7. Provided satisfactory responses to questions asked.	____	____
8. Put away tools and equipment and cleaned work area.	____	____

EVALUATOR'S COMMENTS

PRODUCT EVALUATION

Evaluator Note: Rate the student on the following criteria by circling the appropriate numbers. Each criterion must receive a rating of "3" or higher to demonstrate student mastery. (See performance evaluation key.) A student who is unable to demonstrate mastery should review the materials and submit another product for evaluation.

Criteria				
Product meets manufacturer's installation specifications.	4	3	2	1
Product meets manufacturer's adjustment specifications.	4	3	2	1
Product includes proper components/materials.	4	3	2	1
Product appearance meets industry standards.	4	3	2	1

EVALUATOR'S COMMENTS

AVERAGE RATING

Evaluator Note: To obtain an average rating for the competency profile, total the designated points in "Product Evaluation" and divide by the total number of criteria. Circle the rating on the "Performance Evaluation Key" below.

PERFORMANCE EVALUATION KEY

4 — Skilled — Can perform job with no additional training.
3 — Moderately skilled — Has performed job during training program; limited additional training may be required.
2 — Limited skill — Has performed job during training program; additional training is required to develop skill.
1 — Unskilled — Is familiar with process, but is unable to perform job.

WRITTEN TEST

INTRODUCTION TO AIR CONDITIONING

I

NAME ______________________________ SCORE ________

OBJECTIVE 1

Match terms associated with air conditioning to their definitions. Write the correct letters in the blanks.

______1. The part of the air conditioning system in which refrigerant is turning into gas; includes the metering device to the compressor inlet

______2. The part of the air conditioning system in which refrigerant is turning into liquid; includes the compressor outlet to the metering device

______3. The outside temperature

______4. An air conditioning service station that stores refrigerant for reuse and stops it from flowing into the atmosphere

______5. A chemical that boils at -21.7 degrees Fahrenheit, allowing it to absorb heat easily

a. Refrigerant

b. Coolant

c. High-side

d. Low-side

e. Ambient temperature

f. Recycling center

g. Valiant temperature

OBJECTIVE 2

State the functions of the components of the air conditioning system.

1. **Compressor** — ______________________________
2. **Condenser** — ______________________________
3. **Evaporator** — ______________________________
4. **Accumulator** — ______________________________
5. **Expansion valve/orifice tube** — ______________________________
6. **Receiver/drier** — ______________________________

OBJECTIVE 3

Arrange in order the steps of the air conditioning process. Write "1" in the blank before the first step, a "2" in the blank before the second step, and so on.

______a. The compressor pumps refrigerant into the condenser.

______b. Cool air is blown into the passenger compartment of the car.

______c. The refrigerant turns back into gas (boils) in the evaporator as it absorbs heat from the air surrounding the evaporator.

______d. The refrigerant flows back into the compressor.

______e. The condenser causes the refrigerant to turn into a liquid.

______f. The absorption of heat cools air surrounding the evaporator.

______g. The liquid refrigerant flows into the evaporator through a metering device.

OBJECTIVE 4

Distinguish between the "high-side" and "low-side" of the air conditioning system. Write an "H" in the blank before statements about the high-side and an "L" before statements about the low-side.

______1. Refrigerant is turning into gas.

______2. Refrigerant is under high pressure.

______3. Section from the outlet side of the compressor to the metering device.

______4. Refrigerant is being condensed into a liquid.

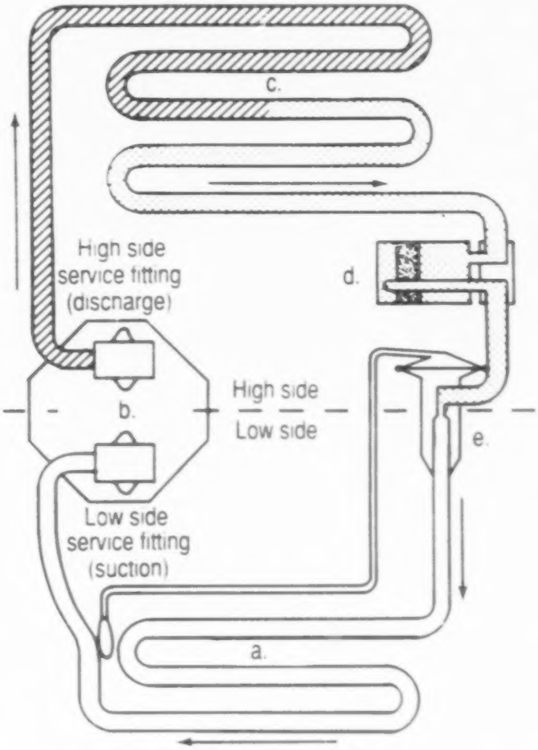
______5. Refrigerant is under lower pressure.

______6. Section from the metering device to the inlet side of the compressor.

OBJECTIVE 5

Label the two types and parts of the air conditioning system.
Write the correct part names and types in the blanks.

- Expansion valve
- Compressor
- Evaporator
- Condenser
- Receiver/drier
- Accumulator
- Expansion tube


c.
High side
service fitting
(discharge)
d.
High side
b.
Low side
e.
Low side
service fitting
(suction)
a.

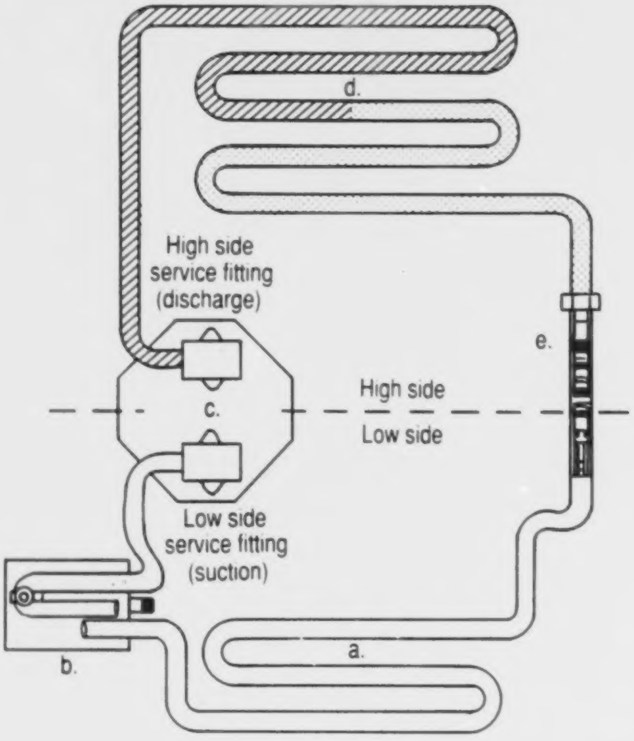
Type: ______________________________

a. ____________________ d. ____________________

b. ____________________ e. ____________________

c. ____________________

- Expansion valve
- Compressor
- Evaporator
- Condenser
- Receiver/drier
- Accumulator
- Expansion tube


d.
High side
service fitting
(discharge)
e.
High side
c.
Low side
Low side
service fitting
(suction)
a.
b.

Type: ______________________________

a. ____________________ d. ____________________

b. ____________________ e. ____________________

c. ____________________

OBJECTIVE 6 **List safety precautions for working on the air conditioning system.**

____

____

____

____

____

____

OBJECTIVE 7 **Match air conditioning system contaminants to their effects.** Write the correct letter in each blank.

______1. Frozen valves and corrosion

______2. High pressure, moisture, and reduced cooling ability

______3. Acid buildup and clogging

______4. Refrigerant breakdown, cooper plating, and zinc/aluminum corrosion

______5. Clogged valves and broken-down oil

______6. Clogged system

______7. Clogged valves and damaged moving parts

______8. Excessive wear on moving parts, refrigerant breakdown, and moisture buildup

a. Air

b. Alcohol

c. Dye

d. Oil

e. Moisture

f. Dirt

g. Rubber

h. Metal pieces

i. Gas

j. Refrigerant

k. Vacuum

l. Incorrect oil

OBJECTIVE 8 **State the functions of air conditioning test equipment.**

1. **Manifold gauge** — ______________________________

____

____

2. **Flame leak detector** — ___________________________

____

____

3. **Electronic leak detector** — _________________________

____

____

4. **Vacuum pump** — ______________________________

____

____

NOTICE The following assignment sheet and job sheets are not part of the written test. If these activities have not been completed, check with your instructor.

OBJECTIVE 9 **Interpret operation charts.** SCORE ______

OBJECTIVE 10a **Perform a system test with a manifold gauge.** RATING ______

OBJECTIVE 10b **Perform a leak test with a flame leak detector.** RATING ______

OBJECTIVE 10c **Perform a leak test with an electronic leak detector.** RATING ______

OBJECTIVE 10d **Discharge the system.** RATING ______

OBJECTIVE 10e **Use a refrigerant recycling center.** RATING ______

OBJECTIVE 10f **Inspect the A/C oil level.** RATING ______

OBJECTIVE 10g	**Evacuate the system.**	RATING ______
OBJECTIVE 10h	**Charge the system.**	RATING ______
OBJECTIVE 10i	**Use a charging station.**	RATING ______

WRITTEN TEST ANSWERS

INTRODUCTION TO AIR CONDITIONING

I

OBJECTIVE 1

1. d
2. c
3. e
4. f
5. a

OBJECTIVE 2

1. **Compressor** — Pumps refrigerant through the air conditioning system
2. **Condenser** — Causes refrigerant to contract, turning it into a liquid
3. **Evaporator** — Allows the refrigerant to boil, turning it into a gas
4. **Accumulator** — Prevents liquid from entering the compressor
5. **Expansion valve/orifice tube** — A metering device that changes high pressure liquid refrigerant into lower pressure liquid by regulating its flow
6. **Receiver/drier** — A device that filters refrigerant

OBJECTIVE 3

a. 1
b. 6
c. 4
d. 7
e. 2
f. 5
g. 3

OBJECTIVE 4

1. L
2. H
3. H
4. H
5. L
6. L

OBJECTIVE 5

Expansion valve type

Type: Expansion valve
a. Evaporator
b. Compressor
c. Condenser
d. Receiver/drier
e. Expansion valve

Expansion tube type

Type: Expansion tube
a. Evaporator
b. Accumulator
c. Compressor
d. Condenser
e. Expansion tube

OBJECTIVE 6

- Always wear safety goggles when working with refrigerant.
- Never open a high pressure valve when charging the system with refrigerant.
- Wrap a rag around the hose connection before opening it.
- Keep flames away from refrigerant.
- Do not allow refrigerant to come in contact with skin.

OBJECTIVE 7

1. e
2. a
3. f
4. b
5. c
6. g
7. h
8. l

OBJECTIVE 8

1. **Manifold gauge** — Readings on the gauges will show the system's high and low side, the current refrigerant level, system efficiency, and diagnosis.
2. **Flame leak detector** — Used to check for refrigerant leaks in the system
3. **Electronic leak detector** — Used to check for refrigerant leaks in the system
4. **Vacuum pump** — A device that removes moisture from refrigerant by lowering the boiling point of water

OBJECTIVE 9

Refer to the answers to Assignment Sheet 1.

OBJECTIVE 10

Refer to Practical Test ratings for Job Sheets 1-9.

OBJECTIVE SHEET

REFRIGERATION SYSTEM

II

INTRODUCTION

The refrigeration system is considered to be one of the most important comfort systems in the car. Stress on the system during the hottest months of the year can cause components to break or fail. A skilled technician must be able to find the problem quickly and fix it properly. This unit concerns the evaporator, compressor, receiver/drier, and condenser of the refrigeration system.

UNIT OBJECTIVE

After completing this unit, the student should be able to identify the components of a refrigeration system, diagnose problems, and inspect and replace components. The student will demonstrate these competencies by completing an assignment sheet, job sheets, practical tests, and the written test with a minimum of 85 percent accuracy.

PREREQUISITE

Electrical Systems Specialist, Unit I

SPECIFIC OBJECTIVES

After completing this unit, the student should be able to

1. State the function of refrigeration system protection devices.
2. Label the types and parts of the compressor.
3. Arrange in order the steps by which a compressor pumps refrigerant through the air conditioning system.
4. Label the parts of the evaporator.
5. Arrange in order the steps by which the evaporator changes refrigerant from liquid to gas.
6. Label the parts of the receiver/drier.
7. Label the parts of the condenser.
8. State the most important function of the compressor.
9. Arrange in order the steps by which the condenser changes refrigerant from gas to liquid.
10. Diagnose problems. (Assignment Sheet 1)

11. Demonstrate the ability to:

   a. Flush a component. (Job Sheet 1)

   b. Inspect and replace a system hose and/or gaskets and O-rings. (Job Sheet 2)

   c. Inspect protection devices. (Job Sheet 3)

   d. Inspect and replace the compressor and compressor mounting hardware. (Job Sheet 4)

   e. Inspect and replace accumulator. (Job Sheet 5)

   f. Inspect and replace the evaporator. (Job Sheet 6)

   g. Inspect and replace the receiver/drier. (Job Sheet 7)

   h. Inspect and replace the condenser. (Job Sheet 8)

   i. Inspect and replace orifice tube or expansion tube. (Job Sheet 9)

PREPARATION

- Review unit and plan presentation.
- Give pretest.
- Determine scope and sequence of objectives that you add. Design and develop support materials, including evaluation techniques, for additional objectives.
- Review teaching suggestions and plan classroom activities.
- Determine how you will schedule time for students to demonstrate competence in the required procedures.
- Order materials to supplement unit.
- Invite a local air conditioning specialist to speak to the class about inspecting and replacing components.

  NOTE: Supply guest speakers with the Objective Sheet, Information Sheet, and any other components you want them to cover.

DELIVERY

Objective 1 State the function of refrigeration system protection devices.

- Stress the importance of keeping refrigeration temperature and pressure within safe ranges.

Objective 2 Label the types and parts of the compressor.

- Explain the compressor to the students in the context of a normal engine. The only difference is that the compressor is a pump driven by the engine.

Objective 3 Arrange in order the steps by which a compressor pumps refrigerant through the air conditioning system.

- Note that the compressor piston is sucking refrigerant in like an engine does fuel.
- Note that the compressor pushes refrigerant out like an engine does exhaust.

Objective 4 Label the parts of the evaporator.

- Note that the evaporator is actually one long tube.
- Point out that the evaporator is the opposite of a condenser.

Objective 5 Arrange in order the steps by which the evaporator charges refrigerant from liquid to gas.

- Explain to the students that the process is continuous.

Objective 6 Label the parts of the receiver/drier.

- Note the connection between each part and the receiver/drier's functions.

Objective 7 Label the parts of the condenser.

- Note that the condenser is one long tube.
- Point out that the condenser is the opposite of an evaporator.

Objective 8 State the most important function of the compressor.

- Stress the temperature/pressure relationship.

Objective 9 Arrange in order the steps by which the condenser changes refrigerant from gas to liquid.

- Explain to the students that the process is continuous.

Objective 10 Diagnose problems. (Assignment Sheet 1)

- Use the assignment sheet to help students diagnose problems.

Objective 11 Demonstrate the ability to:

a. Flush a component. (Job Sheet 1)

b. Inspect and replace a system hose and/or gaskets and O-rings. (Job Sheet 2)

c. Inspect protection devices. (Job Sheet 3)

d. Inspect and replace the compressor and compressor mounting hardware. (Job Sheet 4)

e. Inspect and replace an accumulator. (Job Sheet 5)

f. Inspect and replace the evaporator. (Job Sheet 6)

g. Inspect and replace the receiver/drier. (Job Sheet 7)

h. Inspect and replace the condenser. (Job Sheet 8)

i. Inspect and replace orifice tube or expansion valve. (Job Sheet 9)

EVALUATION

Pretest

- Pretest qualifying students.

- Determine individual requirements from pretest results.

- Counsel students individually on pretest results and study requirements.

Practical test

- Explain to students that they will be asked to demonstrate procedures on the job sheets to complete the practical test.

- Describe the rating scale used on the practical test.

- Reteach and retest as necessary.

Written test

- Explain to students that they will be asked to demonstrate on the written test actions listed in the specific objectives.

- Give written test.

  NOTE: The written test may be given in sections if desired.

- Evaluate students on assignment sheet activities if not previously done.

- Reteach and retest if necessary.

- Complete appropriate section of competency profiles.

- Review individual and group performance in order to evaluate teaching methods. Adjust scope, sequence, or instructional approaches for additional lessons as required.

SUGGESTED RESOURCES

Media

- *Air Conditioning Compressor Seal Service.* OL, MI-8011V-TTS. Available from Career Aids Division, 20417 Nordhoff St., Dept. R 4 5, Chatsworth, CA 91311.

- *Air Conditioning Diagnosis.* OL, MI-8009V-TTS. Available from Career Aids Division, 20417 Nordhoff St., Dept. R 4 5, Chatsworth, CA 91311.

- *Air Conditioning Performance Testing.* Chrysler Corporation, M-8671. Available from ASA, P.O. Box 1047, Bedford, TX 76095.

- *Air Conditioning System.* Ford Parts and Service Division, M-8001. Available from ASA, P.O. Box 1047, Bedford, TX 76095.

- *Automotive Air Conditioning Explained.* B-442X. Available from Teaching Aids, Inc., P.O. Box 1798, Costa Mesa, CA 92628.

- *Automotive Air Conditioning Service.* OL, MI-8008V-TTS. Available from Career Aids Division, 20417, Nordhoff St., Dept R 4 5, Chatsworth, CA 91311.

- *The Automotive Air Conditioner.* Set of 3 VHS cassettes. VHS 1. *Basic Parts and Principles* (17:52 min) addresses principles of air conditioning and identifies components and their functions. Demonstrates flow of freon through the system. VHS 2. *Using the Equipment.* (18:00 min) covers major equipment and tools used in air conditioning maintenance and repair; shows procedures for checking pressure, using freon, finding freon leaks. VHS 3. *Troubleshooting Problems.* (14:02 min) shows students how to detect freon leaks, how to troubleshoot, and how to correct problems. Videotapes can be purchased separately. Available from Bergwall Video Productions, Inc., 1-800-645-3565.

- *The Automotive Cooling System.* 406X-V11. Available from Bergwall Video Productions, Inc., P.O. Box 238, Garden City, NY 11530.

- *Basic Air Conditioning Systems.* OL, MI-8010V-TTS. Available from Career Aids Division, 20417 Nordhoff St., Dept. R 4 5, Chatsworth, CA 91311.

- *Discharge and Evaluation.* R-AB138. Available from Teaching Aids, Inc., P.O. Box 1798, Costa Mesa, CA 92628.

- *Draining the Cooling System.* OL, 010-486-TTS. Available from Career Aids Division, 20417 Nordhoff St., Dept. R 4 5, Chatsworth, CA 91311.

- *Heating and Air Conditioning.* Ford Parts and Service Division M-8669. Available from ASA, P.O. Box 1047, Bedford, TX 76095.

- *Keep Your Car Cool.* MO-706. Available from Teaching Aids, Inc., P.O. Box 1798, Costa Mesa, CA 92628.

- *Principles of Climate Control Air Distribution (Car and Light Truck).* ½" VHS, color, (45:56 min). Covers basics of refrigeration and heat transfer. Shows components and discusses functions; covers electrical system as related to heat and air conditioning. Order No: 3640-006A. Available from Ford Service Publications, P.O. Box 07150, Detroit, MI 48207. To place credit card orders, call 1-800-782-4356.

- *Recharge System.* R-AB139. Available from Teaching Aids, Inc., P.O. Box 1798, Costa Mesa, CA 92628.

- *Refilling the Cooling System.* OL, 010-486-TTS. Available from Career Aids Division, 20417 Nordhoff St., Dept R 4 5, Chatsworth, CA 91311.

NOTE: These films are available to Oklahoma teachers on a free-loan basis. Oklahoma teachers may order these films from the Curriculum and Instructional Materials Center, Oklahoma Department of Vocational and Technical Education, 1500 W. Seventh Avenue, Stillwater, Oklahoma 74074. Out-of-state teachers must order these films direct from the company.

Publications

- *Air Conditioning Systems: Refrigeration 1978-1981 Ford Vehicles.* Loose-leaf instructor guide, with 116 full-color slides and student text; also student text with illustrations, providing information on refrigeration principles, A/C components and their functions, diagnoses and repairs. Order Nos: Instructor Guide, 3631-001 IGK, Student Text, 3631-001 TXT. Available from Ford Service Publications, P.O. Box 07150, Detroit, MI 48207. To place credit card orders, call 1-800-782-4356.

- *Climate Control Systems.* Loose-leaf instructor guide, with 34 full-color slides and student text; also student text with illustrations, providing information on heat transfer and refrigeration: fixed orifice, thermostatic expansion valve systems; electrical system and related functions; diagnoses and repairs. Order Nos: Instructor Guide, 3640-006 IGK, Student Text, 3640-006 TXT. Available from Ford Service Publications, P.O. Box 07150, Detroit, MI 48207. To place credit card orders, call 1-800-782-4356.

- *Refrigerant Systems.* Loose-leaf instructor guide, with 73 full-color slides and student text; also student text with illustrations, providing information on how automotive air conditioning systems work, major components and the fixed-orifice tube system. Order Nos: Instructor Guide, 3631-001 IGK, Student Text, 3631-001 TXT. Available from Ford Service Publications, P.O. Box 07150, Detroit, MI 48207. To place credit card orders, call 1-800-782-4356.

UNIT REFERENCES

- Crouse, William H and Anglin, Donald L. *Automotive Mechanics.* New York, McGraw-Hill Book Company, 1981.

- Dwiggins, Boyce H., *Automotive Air Conditioning.* New York, Delmar Publishers, 1988.

- Mitchell Information Services, Inc., *Mitchell Automechanics.* New Jersey, Prentice Hall, 1982.

- *Automotive Air Conditioning and Heating* 0-02-818620-6, Glencoe Publishing Company, 1-800-257-5775.

- *Automotive Air Conditioning* 014857-0, McGraw-Hill Publishing Company, 1-800-334-7344.

PRETEST ANSWERS

REFRIGERATION SYSTEM

II

EVALUATOR NOTE

Use the following answer key to check student answers to pretest questions. To determine the student's individual study requirements from pretest results, use the following table, which shows the correlation between the objectives and pretest questions. Counsel the students individually on pretest results and study requirements.

TABLE

Correlation between objectives and pretest questions

Objective	Question(s)
1	1, 2, 3, 4
2	5, 6
3	7, 8
4	9
5	10, 11
6	12
7	13
8	14
9	15
10	16, 17
11	18, 19, 20, 21, 22, 23, 24, 25, 26

ANSWER KEY

1.	c	14.	b
2.	b	15.	a
3.	a	16.	c
4.	c	17.	b
5.	b	18.	c
6.	a	19.	b
7.	a	20.	b
8.	c	21.	c
9.	a	22.	b
10.	b	23.	b
11.	c	24.	a
12.	a	25.	c
13.	b	26.	c

REFRIGERATION SYSTEM

NAME ______________________ SCORE ______

DIRECTIONS

Read the following questions and problems. Select the item that best answers the question or problem and write the correct letter in the blank.

OBJECTIVE 1

_____1. The ambient relay prevents the compressor from engaging when the ___.

a. inside temperature rises above 100° F.
b. outside temperature rises above 100° F.
c. outside temperature falls below 32° F.

_____2. The superheat switch prevents the compressor from engaging when the refrigerant ___.

a. pressure is too high
b. temperature is too high
c. temperature is too low

_____3. The thermostat control switch prevents the evaporator from freezing by ___.

a. regulating air discharge temperature
b. preventing the compressor from engaging at freezing temperatures
c. preventing the system from overheating by regulating compressor function

_____4. The device that prevents the compressor from engaging when the refrigerant level is too low is the ___.

a. refrigerant level switch
b. low-pressure level switch
c. low-pressure cutoff switch

OBJECTIVE 2

______5. The part of the compressor that pushes refrigerant into the pressure hose is the ___.

a. pump
b. piston
c. reed valve

______6. The compressor crankshaft connects the ___.

a. piston to the drive belt
b. pump to the drive belt
c. reed valve to the drive belt

OBJECTIVE 3

______7. On a rotary compressor, when the vane moves out the area between the rotor and the compressor wall ___.

a. increases
b. decreases
c. remains the same

______8. The vane begins to move into the rotor when it is ___.

a. 45° from the two ports
b. 90° from the two ports
c. 120° from the two ports

OBJECTIVE 4

______9. Which of the following is NOT a part of the evaporator?

a. Boiling tank
b. Coils
c. Housing

OBJECTIVE 5

_____10. Refrigerant flows into the evaporator from the ___.

a. expansion valve
b. coils
c. boiling tank

_____11. Air surrounding the coils is cooled by ___.

- a. evaporation
- b. condensation
- c. heat absorption

OBJECTIVE 6

_____12. The sight glass is located on the ___.

- a. receiver/drier
- b. evaporator
- c. condenser

OBJECTIVE 7

_____13. The condenser is located ___.

- a. in the passenger compartment
- b. on the radiator
- c. on the compressor

OBJECTIVE 8

_____14. The most important function of the compressor is that it ___.

- a. pumps liquid refrigerant into the condenser
- b. raises the temperature of refrigerant by putting it under pressure
- c. releases heat to the surrounding air, producing high-pressure liquid refrigerant

OBJECTIVE 9

_____15. Refrigerant leaving the condenser is a ___.

- a. cold liquid
- b. hot gas
- c. cold gas

OBJECTIVE 10

_____16. No cold air was coming from the A/C vents. You have fully charged the system, yet the condition remains. This means that ___.

- a. the evaporator is clogged
- b. there is moisture in the system
- c. the condenser is clogged

_____17. A customer shows you that the front carpet of her car is wet. She has noticed drops of water falling from under the dash. You now know that the ___.

a. evaporator has a leak in it
b. drain hose is plugged
c. line to the evaporator has a leak in it

OBJECTIVE 11

_____18. Which of the following is NOT something to look for when inspecting a system hose?

a. Oil
b. Cracks
c. Bent fittings

_____19. When replacing a system hose, ___.

a. rub the refrigerant oil on the insert fillings before flushing the hose
b. flush the hose, rub refrigerant oil on the insert fittings, then hand-start the hose
c. all connections should be tightened to the maximum torque

_____20. What device should be connected to a protection device when inspecting it?

a. An ambient temperature switch
b. An ohmmeter
c. A manifold gauge

_____21. When replacing a compressor, refrigerant lines are disconnected ___.

a. after electrical lines to the compressor are disconnected
b. after the belt pulley is loosened
c. before the belt pulley is loosened

_____22. When replacing the accumulator, you would measure the amount of oil in the old accumulator, replace that much in the new accumulator, and add ___.

a. 2 oz.
b. 3 oz.
c. 4 oz.

_____23. When replacing the evaporator, ___.

a. the outlet hose is disconnected before the inlet hose
b. the inlet hose is disconnected before the outlet hose
c. the inlet and outlet hoses are disconnected after the evaporator is flushed

_____24. When replacing the receiver/drier, the inlet and outlet hoses are disconnected ___.

a. before the receiver/drier mounting bolts
b. after the receiver/drier mounting bolts
c. before the sight glass

_____25. When replacing the condenser, the inlet and outlet hoses are disconnected ___.

a. after the condenser mounting bolts
b. before the condenser is evacuated
c. before the condenser mounting bolts

_____26. The condenser mounting bolts are tightened ___.

a. after the condenser is charged
b. after the inlet and outlet hoses are connected
c. before the inlet and outlet hoses are connected

REFRIGERATION SYSTEM

OBJECTIVE 1

State the function of refrigeration system protection devices.

NOTE: "Engage" means to connect.

- **Ambient relay** — Prevents the compressor from engaging when the outside temperature falls below 32 degrees Fahrenheit

  NOTE: Operation of the air conditioning below freezing temperatures might damage compressor seals.

- **Low-pressure cutoff switch** — Prevents the compressor from engaging when the refrigerant level is too low

  NOTE: A low refrigerant level means that oil has been lost. A low level of oil can cause damage in the compressor.

- **Superheat switch** — Prevents the compressor from engaging when the refrigerant temperature is too high

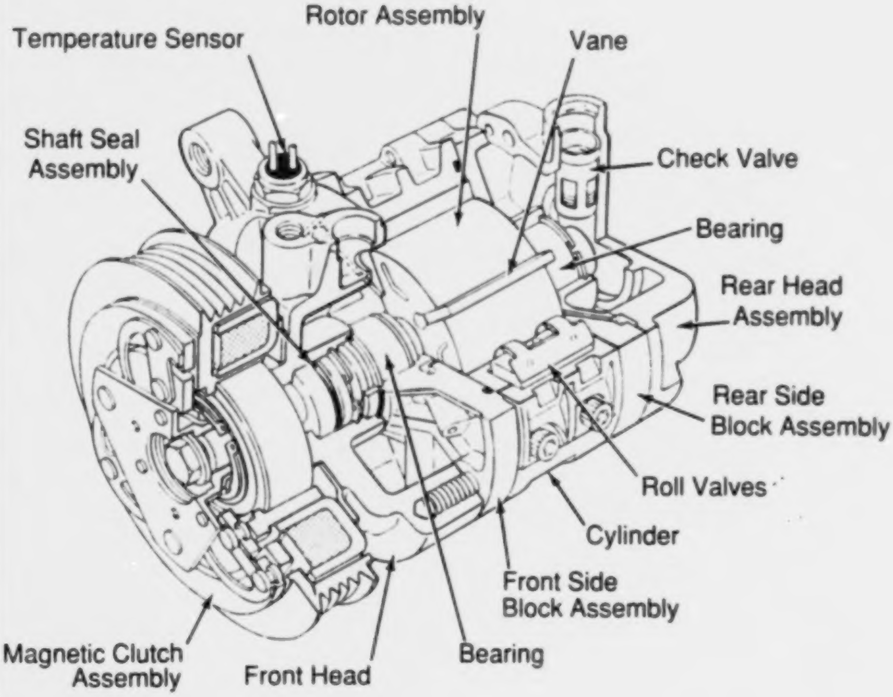
  NOTE: When the refrigerant level is low, its temperature increases, heating the superheat switch. As it heats, the switch begins to close. When fully closed, the switch blows a fuse, preventing the compressor from engaging.

- **Thermostat control switch** — Prevents the evaporator from freezing by regulating air discharge temperature

- **Thermal limiter** — Prevents the compressor from engaging when pressure is too high

OBJECTIVE 2 **Label the types and parts of the compressor.**

Rotary type compressor


Rotor Assembly
Temperature Sensor
Vane
Shaft Seal Assembly
Check Valve
Bearing
Rear Head Assembly
Rear Side Block Assembly
Roll Valves
Cylinder
Front Side Block Assembly
Bearing
Magnetic Clutch Assembly
Front Head

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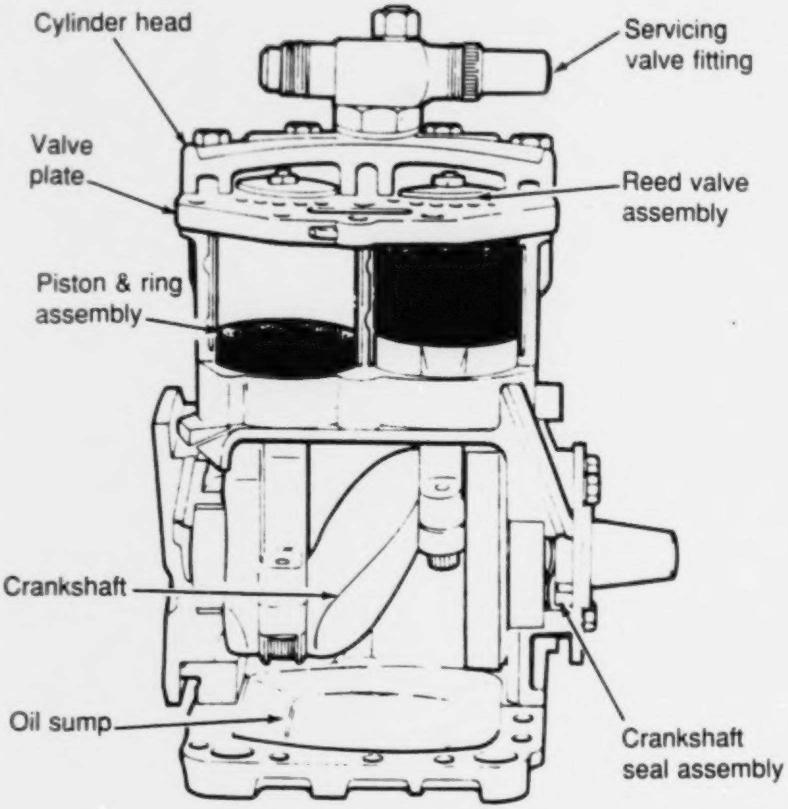
Piston type


Cylinder head
Servicing valve fitting
Valve plate
Reed valve assembly
Piston & ring assembly
Crankshaft
Oil sump
Crankshaft seal assembly

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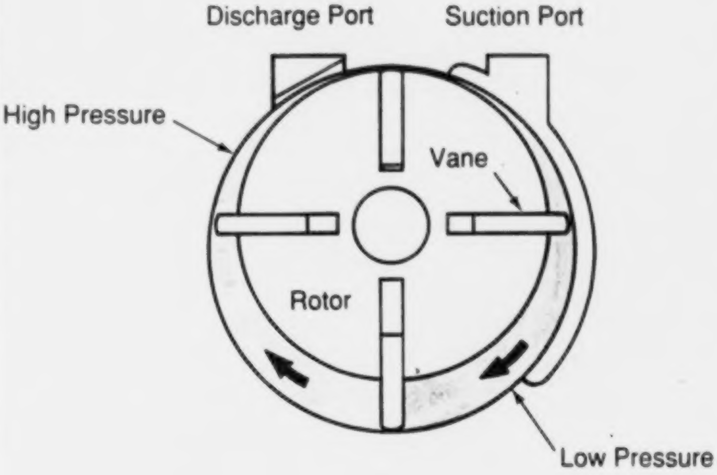
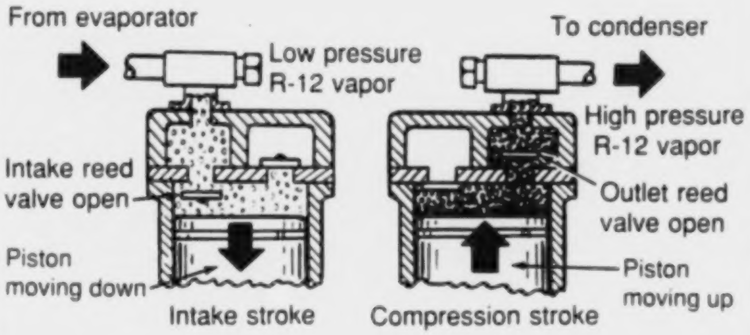
OBJECTIVE 3 **Arrange in order the steps by which a compressor pumps refrigerant through the air conditioning system.**



1. Refrigerant enters the compressor through the suction port.
2. As the rotor spins, a vane moves out to stay in contact with the compressor wall.
3. As the vane moves out, the area between the rotor and the compressor wall increases.
4. More refrigerant is sucked into the compressor.
5. When the vane is 180 degrees from the two ports on the compressor, it begins to move into the rotor.
6. As the vane moves in, the area between the rotor and the compressor wall decreases.
7. As the area between the rotor and the compressor wall decreases, the refrigerant is compressed.
8. High-pressure refrigerant exits the compressor through the discharge port.


From evaporator
Low pressure
R-12 vapor
Intake reed
valve open
Piston
moving down
Intake stroke
To condenser
High pressure
R-12 vapor
Outlet reed
valve open
Piston
moving up
Compression stroke

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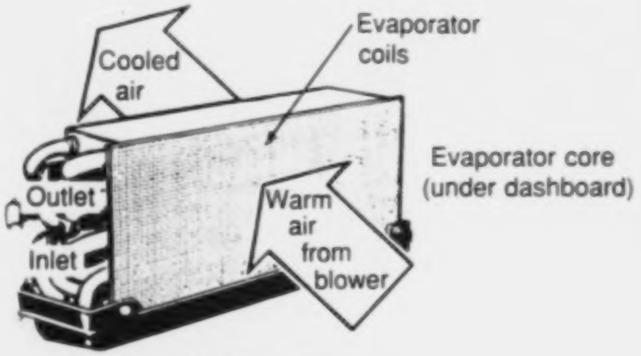
NOTE: The piston is driven by a crankshaft connected to a drive wheel. The drive wheel is driven by a belt connecting it to the engine of the car.

1. The piston begins its downward movement (Intake stroke).
2. Vacuum pulls on the intake valve, opening it.
3. Refrigerant enters the compressor during the downward stroke.
4. The intake valve closes.
5. The outlet valve opens.
6. The piston begins its upward movement (Discharge stroke).
7. Refrigerant is forced out the compressor toward the condenser.

OBJECTIVE 4 **Label the parts of the evaporator.**

Evaporator


Cooled air
Evaporator coils
Evaporator core (under dashboard)
Outlet
Inlet
Warm air from blower

Heat absorbed by evaporator

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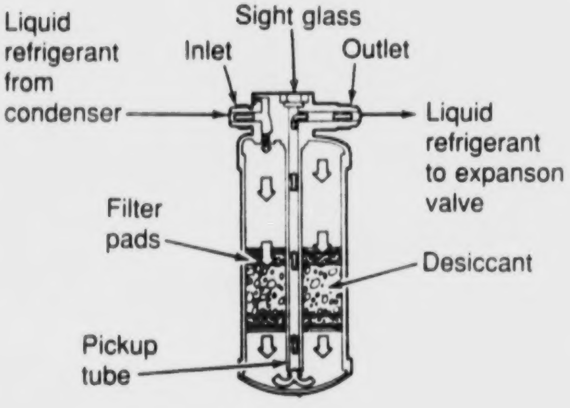
OBJECTIVE 5 **Arrange in order the steps by which the evaporator changes refrigerant from liquid to gas.**

1. Liquid refrigerant flows into the evaporator from the expansion valve.
2. Cold liquid refrigerant flows through the evaporator coils and absorbs heat surrounding the coils.
3. Air surrounding the coils is cooled by the heat absorption.
4. As the cold liquid refrigerant absorbs heat, it changes to low-pressure gas refrigerant.
5. Gas refrigerant flows out the evaporator to the compressor.

OBJECTIVE 6 **Label the parts of the receiver/drier.**

NOTE: The receiver/drier has four functions. It stores liquid refrigerant not needed by the evaporator, sends liquid refrigerant from the condenser to the expansion valve, removes moisture from the refrigerant, and houses the sight glass.

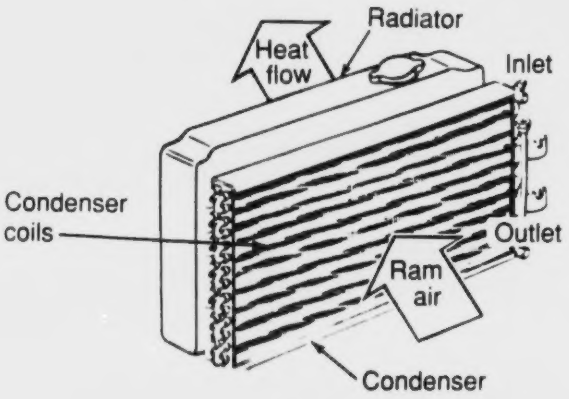
Receiver/drier


Liquid refrigerant from condenser
Sight glass
Inlet
Outlet
Liquid refrigerant to expanson valve
Filter pads
Desiccant
Pickup tube

Used by permission of Glencoe Division, Macmillan-McGraw-Hill Publishing Co.

OBJECTIVE 7 **Label the parts of the condenser.**

Condenser


Radiator
Heat flow
Inlet
Condenser coils
Outlet
Ram air
Condenser

Ram air & heat flow

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OBJECTIVE 8 **State the most important function of the compressor.**

- Raise the temperature of refrigerant by putting it under pressure.

OBJECTIVE 9 **Arrange in order the steps by which the condenser changes refrigerant from gas to liquid.**

NOTE: The condenser is mounted an inch or more in front of the radiator of the car, giving it a maximum amount of airflow from the car's forward motion and the radiator fan. This allows the refrigerant to lose a maximum amount of heat.

1. Hot gas refrigerant is pumped from the compressor toward the condenser.
2. Hot gas refrigerant enters the top of the condenser.
3. Hot gas refrigerant flows through the condenser coils.
4. As the hot gas refrigerant flows through the condenser coils, it releases heat into the air surrounding the condenser.
5. As the gas refrigerant loses heat, it begins to turn into cold, high-pressure liquid refrigerant.

REFRIGERATION SYSTEM

The table below represents a common diagnostic chart. The chart varies with the cars. Consult the service manual when actually making diagnostic decisions.

Symptom (Effect)	**Problem (Cause)**
No cold air from vents	Clogged condenser Undercharged system Clogged receiver/drier
Semi-cold air from vents	Undercharged system Air in the system
Odor from air conditioning	A odor-producing substance in the evaporator case Condensation in evaporator housing
Frost on evaporator	Faulty thermostat
Water dripping from evaporator	Plugged drain hose
No change in air temperature when switching from vent to A/C	Receiver/drier plugged
Compressor is noisy	Incorrect charge in the system Moisture in system

ACTIVITY SHEET 1

REFRIGERATION SYSTEM

II

NAME ______________________________

COMPARE THE AUTO REFRIGERATION SYSTEM TO ONE IN A REFRIGERATOR

Notice the coils on the back of the refrigerator. Are they hot or cold? Using your knowledge of auto refrigeration systems, are they condenser or evaporator coils? If they are condenser coils, where do you suspect the evaporator coils are? If they are evaporator coils, where are the condenser coils?

ASSIGNMENT SHEET 1

REFRIGERATION SYSTEM

II

NAME ______________________________ SCORE ______

OBJECTIVE 10 **Diagnose problems.**

INTRODUCTION

The refrigeration system in a car is a complex system of components that can break down. The technician's job is to look for and recognize specific problems and to identify the component that is not working. The component can then be fixed or replaced. If the first procedure fails to correct the problem, or reveals another problem, the technician continues to inspect, repair, or replace components as needed until the system is functioning properly.

DIRECTIONS

Read each problem carefully. Use the table in Supplement 1 to identify the BEST cause, and write the correct letter in the blank.

______1. Mrs. Jones brings her car to you with the complaint that there is a strange odor coming from the air conditioning. The problem is that there is ___.

a. air in the system
b. an odor-producing substance in the evaporator case
c. a clogged condenser

______2. You are working on Mr. Bernstein's air conditioning. You have fully charged the system, yet no cold air comes out the vents. The problem is that ___.

a. the evaporator is clogged
b. there is moisture in the system
c. the condenser is clogged

______3. Miss Jiminez brings her car to you. She says that when she switches from vent to A/C, the temperature of air coming out the vents does not change. The problem is that the ___.

a. receiver/drier is plugged
b. evaporator is plugged
c. compressor is plugged

______4. You fix Miss Jiminez's car in #3 above. Now, however, you notice an odor coming from under the dash. The problem is that condensation has collected ___.

a. on the evaporator coils
b. on the condenser coils
c. in the bottom of the evaporator housing

______5. Mrs. Rainwater brings her car to you. She shows you that the front carpet is wet. While looking at it, you notice a drop of water fall from under the dash. You now know that the ___.

a. evaporator has a leak in it
b. drain hose is plugged
c. line to the evaporator has a leak in it

______6. You have just charged a customer's car with refrigerant. You have turned the A/C on to test it. When you look at the evaporator, you notice frost on the coils. You know that the ___.

a. thermostat is faulty
b. system is overcharged
c. evaporator is plugged

______7. When working on a car, you notice the compressor makes a lot of noise when it is engaged. The problem is that the ___.

a. thermostat is faulty
b. receiver/drier is plugged
c. there is moisture in the system

______8. A customer complains that the air coming from the vents when the A/C is on is semi-cold. The problem is ___.

a. air in the system
b. blown compressor fuse
c. a low level of oil in the system

______9. You notice that the air conditioning system in your customer's car does not cool air at all. The problem is that the ___.

a. evaporator drain hose is plugged
b. receiver/drier is plugged
c. system is overcharged

ASSIGNMENT SHEET 1

1. b
2. c
3. a
4. c
5. b
6. a
7. c
8. a
9. b

JOB
SHEET 1

REFRIGERATION SYSTEM

II

OBJECTIVE 11a **Flush a component.**

TOOLS AND EQUIPMENT

- Eye protection
- Flush gun
- Flush solvent

PROCEDURE

1. Connect flush gun to component.
2. Connect can tap to flush solvent container.
3. Push flush gun into component.

   NOTE: This will start the flow of solvent through the component.

4. When solvent exits the other end of the component, disconnect flush gun.
5. Have your instructor check your work.
6. Put away tools and equipment and clean the work area.

OBJECTIVE 11b

Inspect and replace a system hose and/or gaskets and O-rings.

TOOLS AND EQUIPMENT

- Eye protection
- Refrigeration oil
- Replacement pressure hose
- Screwdriver
- Pliers
- Special tools as needed
- Service manual

> **CAUTION**
> **Always** check the procedure in the vehicle's service manual before beginning any service or repair.

PROCEDURE 1

Inspect a system hose.

1. Look carefully for cracks in each hose in the refrigeration system.

   NOTE: A cracked hose can be found with a leak detector. Also, a cracked hose will usually have oil leaking out of it. (See Unit I.)

2. If any cracks are found, perform procedure 2.

3. Report any cracks to your instructor.

PROCEDURE 2

Replace a system hose and/or gaskets and O-rings.

NOTE: The system must be discharged before this procedure and evacuated and charged after. When charging, add oil as needed.

1. Use a suitable tool for loosening or removing hose connections.

2. Compare replacement hose to original. If there is any difference, see your instructor.

3. Check that the proper gaskets and/or O-rings are attached.

♦ WARNING ♦

Replacement O-rings and gaskets must be exactly the same quality and size as the old ones.

4. Flush hose. (See Job Sheet 1.)
5. Rub refrigerant oil on the ends of the insert fittings and/or gaskets and O-rings.
6. Hand-start the hose connections to be sure they are properly fitted.
7. Tighten all connections to the proper torque.

CAUTION

Over-tightening may damage hose fittings.

8. Tighten clamps, if equipped.
9. Evacuate the system. (Unit I, Job Sheet 7.)
10. Begin charging the system. (Unit I, Job Sheet 8.)
11. Before finishing the charge, start engine.
12. Leak test the system.
13. Complete the charge.
14. Have your instructor check your work.
15. Put away tools and equipment and clean the work area.

JOB SHEET 3

REFRIGERATION SYSTEM

OBJECTIVE 11c

Inspect protection devices.

TOOLS AND EQUIPMENT

- Eye protection
- Owner's manual
- Service manual

> **CAUTION**
> **Always** check the procedure in the vehicle's service manual before beginning any service or repair.

NOTE: Not all cars have the following switches. Consult the service manual.

PROCEDURE

1. Locate the ambient temperature switch. Consult the owner's manual for its location.

CAUTION

When using the ohmmeter, be sure voltage is removed from the circuit.

2. Attach the ohmmeter to the positive and negative terminals on the ambient switch.
3. Compare the ohmmeter reading to the manufacturer's specification for the ambient switch.
4. Locate the thermal limiter and superheat switch.
5. Refer to service manual to test.
6. Locate the thermostat control switch.
7. Attach the ohmmeter to the positive and negative terminals on the thermostat control switch.
8. Compare the ohmmeter reading to the manufacturer's specification for the thermostat control switch.
9. Locate the low-pressure cutoff switch.

10. Attach the ohmmeter to the positive and negative terminals on the low-pressure cutoff switch.

11. Compare the ohmmeter reading to the manufacturer's specification for the low-pressure cutoff switch.

12. Report all readings to your instructor; identify protection devices with incorrect readings.

13. Put away tools and equipment and clean the work area.

JOB SHEET 4

REFRIGERATION SYSTEM

II

OBJECTIVE 11d

Inspect and replace the compressor and compressor mounting hardware.

TOOLS AND EQUIPMENT

- Eye protection
- Wrenches
- Assorted line plugs
- Screwdriver
- New compressor
- New compressor mounting hardware
- Service manual

> **CAUTION**
> **Always** check the procedure in the vehicle's service manual before beginning any service or repair.

PROCEDURE 1

Inspect compressor and compressor mounting hardware.

1. Look for damaged or worn parts, bolts, or wires on the compressor and mounting hardware.
2. If anything is damaged, perform procedure 2.
3. Report findings to your instructor.

PROCEDURE 2

Replace compressor and compressor mounting hardware.

NOTE: The refrigeration system must be discharged before this procedure and evacuated and charged after it. When charging, add oil as needed and change the receiver/drier. (See Unit I.)

1. Disconnect power source.
2. Use the proper wrench to disconnect the two refrigerant lines connected to the compressor.

   NOTE: On some cars, it may be easier to wait until Step 8.

3. Press a line plug into the end of each refrigerant line.

   NOTE: This will keep anything from getting into the hose.

4. Loosen the drive belt pulley and tension adjustors.

5. Loosen the bolts on the mounting hardware of the compressor.

6. Remove the drive belt from the compressor.

7. Disconnect any electrical lines to the compressor.

8. Use the proper wrenches to remove all remaining bolts holding the compressor to the compressor mount.

9. Lift the compressor from the engine.

10. Disconnect mounting hardware.

11. Connect new mounting hardware.

12. Place the new compressor into the compressor's mounting hardware.

13. Replace the compressor mounting hardware bolts.

    NOTE: Tighten the bolts finger-tight.

14. Slip the drive belt back onto the compressor drive pulley.

15. Tighten all bolts between the compressor and compressor mounting hardware.

16. Adjust belt pulley and tension adjustors to manufacturer's specifications. (See service manual.)

17. Check alignment of compressor pulley with other pulleys.

18. Adjust tension adjustors or idle pulleys to manufacturer's specifications. (See service manual.)

19. Reconnect all electrical wires to the compressor.

20. Have your instructor check your work.

21. Put away tools and equipment and clean the work area.

JOB SHEET 5

REFRIGERATION SYSTEM

II

OBJECTIVE 11e

Inspect and replace accumulator.

TOOLS AND EQUIPMENT

- Eye protection
- Proper wrenches
- Service manual
- New accumulator
- Refrigerant oil

> **CAUTION**
> **Always** check the procedure in the vehicle's service manual before beginning any service or repair.

PROCEDURE 1

Inspect the accumulator.

1. Locate the accumulator.
2. Look for damaged connections or parts.
3. If anything is damaged, report to instructor.
4. Have your instructor check your work.
5. Put away tools and equipment and clean the work area.

PROCEDURE 2

Replace the accumulator.

1. Discharge the system. (See Unit I, Job Sheet 4.)
2. Disconnect power source.
3. Disconnect hoses from accumulator.
4. Disconnect electrical connections to the accumulator.
5. Remove bolts connection accumulator to accumulator mounting hardware, if equipped.
6. Remove accumulator from accumulator mounting hardware.

7. Note the amount of refrigerant oil in old accumulator.
8. Add the amount of oil above plus three ounces to new accumulator.
9. Place new accumulator in accumulator mounting hardware.
10. Reconnect bolts connecting accumulator to accumulator mounting hardware.
11. Reconnect electrical connections.
12. Reconnect hoses to accumulator.
13. Reconnect power source.
14. Evacuate the system. (See Unit I, Job Sheet 7.)
15. Charge the system. (See Unit I, Job Sheet 8.)
16. Have your instructor check your work.
17. Put away tools and equipment and clean the work area.

JOB SHEET 6

REFRIGERATION SYSTEM

II

OBJECTIVE 11f **Inspect and replace the evaporator.**

TOOLS AND EQUIPMENT

- Eye protection
- Wrenches
- Screwdriver
- New evaporator
- Service manual

> **CAUTION**
> **Always** check the procedure in the vehicle's service manual before beginning any service or repair.

PROCEDURE 1 **Inspect evaporator.**

1. Look for damaged or worn parts or bolts on the evaporator.
2. If anything is damaged, perform procedure 2.
3. Report findings to your instructor.

PROCEDURE 2 **Replace evaporator.**

NOTE: The refrigeration system must be discharged before this procedure and evacuated and charged after it. When charging, add oil as needed and change the receiver/drier. (See Unit I.)

1. Locate the evaporator.

   NOTE: It will either be under the dash or mounted to the firewall in the engine compartment. If it is located under the dash, remove parts of the dash as needed.

2. Disconnect the inlet hose with the proper wrench.

3. Disconnect the outlet hose with the proper wrench.

4. Remove the bolts holding the evaporator to the car.

5. Remove the evaporator from the car.

6. Flush the evaporator. (See Job Sheet 1.)

7. Place new evaporator into the car.

8. Insert bolts into evaporator and mount.

9. Tighten bolts using the proper wrench.

10. Reconnect the outlet hose.

11. Reconnect the inlet hose.

12. Have your instructor check your work.

13. Put away tools and equipment and clean the work area.

JOB
SHEET 7

REFRIGERATION SYSTEM

II

OBJECTIVE 11g **Inspect and replace the receiver/drier.**

TOOLS AND EQUIPMENT

- Eye protection
- Wrench
- Screwdriver
- New receiver/drier
- Service manual

> **CAUTION**
> **Always** check the procedure in the vehicle's service manual before beginning any service or repair.

CAUTION

If plugs are not installed on new receiver/drier, do not use it.

PROCEDURE 1 **Inspect receiver/dryer.**

1. Look for damaged or worn parts or bolts on the receiver/drier.
2. If anything is damaged, perform procedure 2.
3. Report findings to your instructor.

PROCEDURE 2 **Replace receiver/dryer.**

NOTE: The refrigeration system must be discharged before this procedure and evacuated and charged after it. When charging, add oil as needed. (See Unit I.)

1. Disconnect the inlet hose with the proper wrench.
2. Disconnect the outlet hose with the proper wrench.

3. Remove the bolts holding the receiver/drier to the car.

4. Remove the receiver/drier from the car.

5. Place new receiver/drier into the car.

   NOTE: Try to install it at the same angle as before.

6. Insert bolts into receiver/drier and mount.

7. Tighten bolts with the proper wrench.

8. Reconnect the outlet hose.

9. Reconnect the inlet hose.

10. Have your instructor check your work.

11. Put away tools and equipment and clean the work area.

OBJECTIVE 11h

Inspect and replace the condenser.

TOOLS AND EQUIPMENT

- Eye protection
- Wrenches
- Screwdriver
- New condenser
- Owner's manual
- Service manual

> **CAUTION**
> **Always** check the procedure in the vehicle's service manual before beginning any service or repair.

PROCEDURE 1

Inspect condenser.

1. Look for damaged or worn parts, bolts or bent fins on the condenser.

2. Remove leaves, bugs, or other debris on the condenser coils.

3. If anything is damaged, perform procedure 2.

4. Report findings to your instructor.

PROCEDURE 2

Replace condenser.

NOTE: The refrigeration system must be discharged before this procedure and evacuated and charged after it. When charging, add oil as needed and change the receiver/drier. (See Unit I.)

1. Disconnect the inlet hose with the proper wrench.

2. Disconnect the outlet hose with the proper wrench.

3. Remove the bolts holding the condenser to the car.

4. Remove the condenser from the car.

5. Flush condenser. (See Job Sheet 1.)

6. Place the new condenser into the car.

   CAUTION

   Be careful not to damage or cut yourself with condenser fins.

7. Insert bolts into condenser and mount.

8. Tighten bolts with the proper wrench.

9. Reconnect the outlet hose.

10. Reconnect the inlet hose.

11. Have your instructor check your work.

12. Put away tools and equipment and clean the work area.

JOB SHEET 9

REFRIGERATION SYSTEM

II

OBJECTIVE 11i **Inspect and replace orifice tube or expansion valve.**

TOOLS AND EQUIPMENT

- Eye protection
- Proper wrenches
- Service manual
- New orifice tube or expansion valve
- Refrigerant oil

PROCEDURE 1 **Inspect orifice tube or expansion valve.**

1. Locate the orifice tube or expansion valve.
2. Look for damaged connections or parts.
3. If anything is damaged, report to instructor.
4. Have your instructor check your work.
5. Put away tools and equipment and clean the work area.

PROCEDURE 2 **Replace orifice tube or expansion valve.**

1. Discharge the system. (See Unit I, Job Sheet 4.)
2. Disconnect hoses from orifice tube or expansion valve.
3. Remove orifice tube or expansion valve.
4. Rub refrigerant oil on new orifice tube or expansion valve.
5. Put new orifice tube or expansion valve in place.
6. Reconnect hoses to orifice tube or expansion valve.
7. Evacuate the system. (See Unit I, Job Sheet 7.)
8. Charge the system. (See Unit I, Job Sheet 8.)
9. Have your instructor check your work.
10. Put away tools and equipment and clean the work area.

JOB SHEET 1

Flush a component.

STUDENT'S NAME ____________________ DATE ______________

EVALUATOR'S NAME __________________ ATTEMPT NO. ______

INSTRUCTIONS

When you are ready to perform this task, ask your instructor to observe the procedure and complete this form. All items listed under "Process Evaluation" must receive a "Yes" for you to receive an acceptable performance evaluation.

PROCESS EVALUATION

Evaluator Note: Place a check mark in the "Yes" or "No" blanks to designate whether or not the student has satisfactorily achieved each step in this procedure. If the student is unable to achieve this competency, have the student review the materials and try again.

The student	YES	NO
1. Connected flush gun to component.	_____	_____
2. Connected can tap to flush solvent container.	_____	_____
3. Pushed flush gun into component.	_____	_____
4. When solvent exited other end of the component, disconnected flush gun.	_____	_____
5. Used proper tools correctly.	_____	_____
6. Performed steps in a timely manner.	_____	_____
7. Practiced safety rules throughout procedure.	_____	_____
8. Provided satisfactory responses to questions asked.	_____	_____
9. Put away tools and equipment and cleaned work area.	_____	_____

EVALUATOR'S COMMENTS

PRODUCT EVALUATION

Evaluator Note: Rate the student on the following criteria by circling the appropriate numbers. Each criterion must receive a rating of "3" or higher to demonstrate student mastery. (See performance evaluation key.) A student who is unable to demonstrate mastery should review the materials and submit another product for evaluation.

Criteria				
Product meets manufacturer's installation specifications.	4	3	2	1
Product meets manufacturer's adjustment specifications.	4	3	2	1
Product includes proper components/materials.	4	3	2	1
Product appearance meets industry standards.	4	3	2	1

EVALUATOR'S COMMENTS

AVERAGE RATING

Evaluator Note: To obtain an average rating for the competency profile, total the designated points in "Product Evaluation" and divide by the total number of criteria. Circle the rating on the "Performance Evaluation Key" below.

PERFORMANCE EVALUATION KEY

4 —	Skilled — Can perform job with no additional training.
3 —	Moderately skilled — Has performed job during training program; limited additional training may be required.
2 —	Limited skill — Has performed job during training program; additional training is required to develop skill.
1 —	Unskilled — Is familiar with process, but is unable to perform job.

PRACTICAL TEST 2

REFRIGERATION SYSTEM

II

JOB SHEET 2

Inspect and replace a system hose and/or gaskets and O-rings.

STUDENT'S NAME ____________________ DATE ______________

EVALUATOR'S NAME ________________ ATTEMPT NO. _____

INSTRUCTIONS

When you are ready to perform this task, ask your instructor to observe the procedure and complete this form. All items listed under "Process Evaluation" must receive a "Yes" for you to receive an acceptable performance evaluation.

PROCESS EVALUATION

Evaluator Note: Place a check mark in the "Yes" or "No" blanks to designate whether or not the student has satisfactorily achieved each step in this procedure. If the student is unable to achieve this competency, have the student review the materials and try again.

The student	YES	NO
Procedure 1: Inspected a system hose and/or gaskets and O-rings.		
1. Looked carefully for cracks.	_____	_____
2. If any hoses had cracks, proceeded to procedure 2.	_____	_____
3. Reported to instructor.	_____	_____
Procedure 2: Replaced a system hose and/or gaskets and O-rings.		
1. Loosened hose connections.	_____	_____
2. Compared replacement to original.	_____	_____
3. Checked gaskets and/or O-rings.	_____	_____
4. Flushed hose.	_____	_____
5. Connected hose properly.	_____	_____
6. Evacuated system.	_____	_____

	YES	NO
7. Charged system.	____	____
8. Leak tested system.	____	____
9. Used proper tools correctly.	____	____
10. Performed steps in a timely manner.	____	____
11. Practiced safety rules throughout procedure.	____	____
12. Provided satisfactory responses to questions asked.	____	____
13. Put away tools and equipment and cleaned work area.	____	____

EVALUATOR'S COMMENTS ____

____

PRODUCT EVALUATION

Evaluator Note: Rate the student on the following criteria by circling the appropriate numbers. Each criterion must receive a rating of "3" or higher to demonstrate student mastery. (See performance evaluation key.) A student who is unable to demonstrate mastery should review the materials and submit another product for evaluation.

Criteria				
Product meets manufacturer's installation specifications.	4	3	2	1
Product meets manufacturer's adjustment specifications.	4	3	2	1
Product includes proper components/materials.	4	3	2	1
Product appearance meets industry standards.	4	3	2	1

EVALUATOR'S COMMENTS

AVERAGE RATING

Evaluator Note: To obtain an average rating for the competency profile, total the designated points in "Product Evaluation" and divide by the total number of criteria. Circle the rating on the "Performance Evaluation Key" below.

PERFORMANCE EVALUATION KEY

4 — Skilled — Can perform job with no additional training.
3 — Moderately skilled — Has performed job during training program; limited additional training may be required.
2 — Limited skill — Has performed job during training program; additional training is required to develop skill.
1 — Unskilled — Is familiar with process, but is unable to perform job.

PRACTICAL TEST 3

REFRIGERATION SYSTEM

JOB SHEET 3

Inspect protection devices.

STUDENT'S NAME ____________________ DATE ______________

EVALUATOR'S NAME ____________________ ATTEMPT NO. ______

INSTRUCTIONS

When you are ready to perform this task, ask your instructor to observe the procedure and complete this form. All items listed under "Process Evaluation" must receive a "Yes" for you to receive an acceptable performance evaluation.

PROCESS EVALUATION

Evaluator Note: Place a check mark in the "Yes" or "No" blanks to designate whether or not the student has satisfactorily achieved each step in this procedure. If the student is unable to achieve this competency, have the student review the materials and try again.

The student	YES	NO
1. Located the ambient switch.	_____	_____
2. Attached the ohmmeter to the ambient switch.	_____	_____
3. Compared the ohmmeter reading to the manufacturer's specification.	_____	_____
4. Located the thermal limiter and superheat switch.	_____	_____
5. Consulted service manual to check thermal limiter and superheat switch.	_____	_____
6. Located the thermostat control switch.	_____	_____
7. Attached the ohmmeter to the thermostat control switch.	_____	_____
8. Compared the ohmmeter reading to the manufacturer's switch.	_____	_____
9. Located the low-pressure cutoff switch.	_____	_____

	YES	NO
10. Attached the ohmmeter to the low-pressure cutoff switch.	_____	_____
11. Compared the ohmmeter reading to the manufacturer's specification.	_____	_____
12. Reported protection devices with incorrect readings.	_____	_____
13. Used proper tools correctly.	_____	_____
14. Performed steps in a timely manner.	_____	_____
15. Practiced safety rules throughout procedure.	_____	_____
16. Provided satisfactory responses to questions asked.	_____	_____
17. Put away tools and equipment and cleaned work area.	_____	_____

EVALUATOR'S COMMENTS ____

____

PRODUCT EVALUATION

Evaluator Note: Rate the student on the following criteria by circling the appropriate numbers. Each criterion must receive a rating of "3" or higher to demonstrate student mastery. (See performance evaluation key.) A student who is unable to demonstrate mastery should review the materials and submit another product for evaluation.

Criteria				
Product meets manufacturer's installation specifications.	4	3	2	1
Product meets manufacturer's adjustment specifications.	4	3	2	1
Product includes proper components/materials.	4	3	2	1
Product appearance meets industry standards.	4	3	2	1

EVALUATOR'S COMMENTS

____

____

____

AVERAGE RATING

Evaluator Note: To obtain an average rating for the competency profile, total the designated points in "Product Evaluation" and divide by the total number of criteria. Circle the rating on the "Performance Evaluation Key" below.

PERFORMANCE EVALUATION KEY

4 — Skilled — Can perform job with no additional training.
3 — Moderately skilled — Has performed job during training program; limited additional training may be required.
2 — Limited skill — Has performed job during training program; additional training is required to develop skill.
1 — Unskilled — Is familiar with process, but is unable to perform job.

JOB SHEET 4

Inspect and replace the compressor and compressor mounting hardware.

STUDENT'S NAME ____________________ DATE ____________

EVALUATOR'S NAME ____________________ ATTEMPT NO. ______

INSTRUCTIONS

When you are ready to perform this task, ask your instructor to observe the procedure and complete this form. All items listed under "Process Evaluation" must receive a "Yes" for you to receive an acceptable performance evaluation.

PROCESS EVALUATION

Evaluator Note: Place a check mark in the "Yes" or "No" blanks to designate whether or not the student has satisfactorily achieved each step in this procedure. If the student is unable to achieve this competency, have the student review the materials and try again.

The student	YES	NO
Procedure 1: Inspected compressor and compressor mounting hardware.		
1. Looked for damaged parts, bolts, or wires on compressor and hardware.	_____	_____
2. If anything was damaged, performed procedure 2.	_____	_____
3. Reported to instructor.	_____	_____
Procedure 2: Replaced compressor and compressor mounting hardware.		
1. Disconnected power source.	_____	_____
2. Disconnected the two refrigerant lines.	_____	_____
3. Pressed a line plug into the end of each refrigerant line.	_____	_____

		YES	NO
4.	Loosened the drive belt pulley and tension adjustors.	_____	_____
5.	Loosened the bolts on the compressor mounting hardware.	_____	_____
6.	Removed the drive belt from the compressor.	_____	_____
7.	Disconnected electrical lines to the compressor.	_____	_____
8.	Removed the bolts holding the compressor.	_____	_____
9.	Lifted the compressor from the engine.	_____	_____
10.	Replaced compressor mounting hardware.	_____	_____
11.	Placed new compressor into the compressor's mounting hardware.	_____	_____
12.	Replaced bolts holding compressor to compressor's mounting hardware.	_____	_____
13.	Slipped the drive belt back onto the compressor drive pulley.	_____	_____
14.	Tightened all bolts between the compressor and compressor mounting hardware.	_____	_____
15.	Adjusted belt pulley.	_____	_____
16.	Checked compressor alignment.	_____	_____
17.	Adjusted tension adjustors.	_____	_____
18.	Reconnected electrical wires to the compressor.	_____	_____
19.	Reported to instructor.	_____	_____
20.	Used proper tools correctly.	_____	_____

	YES	NO
21. Performed steps in a timely manner.	____	____
22. Practiced safety rules throughout procedure.	____	____
23. Provided satisfactory responses to questions asked.	____	____
24. Put away tools and equipment and cleaned work area.	____	____

EVALUATOR'S COMMENTS ____

____

PRODUCT EVALUATION

Evaluator Note: Rate the student on the following criteria by circling the appropriate numbers. Each criterion must receive a rating of "3" or higher to demonstrate student mastery. (See performance evaluation key.) A student who is unable to demonstrate mastery should review the materials and submit another product for evaluation.

Criteria				
Product meets manufacturer's installation specifications.	4	3	2	1
Product meets manufacturer's adjustment specifications.	4	3	2	1
Product includes proper components/materials.	4	3	2	1
Product appearance meets industry standards.	4	3	2	1

EVALUATOR'S COMMENTS

AVERAGE RATING

Evaluator Note: To obtain an average rating for the competency profile, total the designated points in "Product Evaluation" and divide by the total number of criteria. Circle the rating on the "Performance Evaluation Key" below.

PERFORMANCE EVALUATION KEY

4 — Skilled — Can perform job with no additional training.
3 — Moderately skilled — Has performed job during training program; limited additional training may be required.
2 — Limited skill — Has performed job during training program; additional training is required to develop skill.
1 — Unskilled — Is familiar with process, but is unable to perform job.

JOB SHEET 5

Inspect and replace accumulator.

STUDENT'S NAME ________________ DATE __________

EVALUATOR'S NAME ________________ ATTEMPT NO. _____

INSTRUCTIONS

When you are ready to perform this task, ask your instructor to observe the procedure and complete this form. All items listed under "Process Evaluation" must receive a "Yes" for you to receive an acceptable performance evaluation.

PROCESS EVALUATION

Evaluator Note: Place a check mark in the "Yes" or "No" blanks to designate whether or not the student has satisfactorily achieved each step in this procedure. If the student is unable to achieve this competency, have the student review the materials and try again.

The student	YES	NO
Procedure 1: Inspected accumulator		
1. Located the accumulator.	_____	_____
2. Looked for damaged connections or parts.	_____	_____
3. If anything was damaged, reported to instructor.	_____	_____
4. Used proper tools correctly.	_____	_____
5. Performed steps in a timely manner.	_____	_____
6. Practiced safety rules throughout procedure.	_____	_____
7. Provided satisfactory responses to questions asked.	_____	_____
8. Put away tools and equipment and cleaned work area.	_____	_____

Procedure 2: Replaced accumulator

		YES	NO
1.	Discharged the system.	_____	_____
2.	Disconnected power source.	_____	_____
3.	Disconnected hoses from accumulator.	_____	_____
4.	Disconnected electrical connections to the accumulator.	_____	_____
5.	Removed bolts connection accumulator to accumulator mounting hardware, if equipped.	_____	_____
6.	Removed accumulator from accumulator mounting hardware.	_____	_____
7.	Noted the amount of refrigerant oil in old accumulator.	_____	_____
8.	Added the amount of oil above plus three ounces to new accumulator.	_____	_____
9.	Placed new accumulator in accumulator mounting hardware.	_____	_____
10.	Reconnected bolts connecting accumulator to accumulator mounting hardware.	_____	_____
11.	Reconnected electrical connections.	_____	_____
12.	Reconnected hoses to accumulator.	_____	_____
13.	Reconnected power source.	_____	_____
14.	Evacuated the system.	_____	_____
15.	Charged the system.	_____	_____
16.	Used proper tools correctly.	_____	_____
17.	Performed steps in a timely manner.	_____	_____

	YES	NO
18. Practiced safety rules throughout procedure.	____	____
19. Provided satisfactory responses to questions asked.	____	____
20. Put away tools and equipment and cleaned work area.	____	____

EVALUATOR'S COMMENTS ____

____

PRODUCT EVALUATION

Evaluator Note: Rate the student on the following criteria by circling the appropriate numbers. Each criterion must receive a rating of "3" or higher to demonstrate student mastery. (See performance evaluation key.) A student who is unable to demonstrate mastery should review the materials and submit another product for evaluation.

Criteria				
Product meets manufacturer's installation specifications.	4	3	2	1
Product meets manufacturer's adjustment specifications.	4	3	2	1
Product includes proper components/materials.	4	3	2	1
Product appearance meets industry standards.	4	3	2	1

EVALUATOR'S COMMENTS

AVERAGE RATING

Evaluator Note: To obtain an average rating for the competency profile, total the designated points in "Product Evaluation" and divide by the total number of criteria. Circle the rating on the "Performance Evaluation Key" below.

PERFORMANCE EVALUATION KEY

4 — Skilled — Can perform job with no additional training.
3 — Moderately skilled — Has performed job during training program; limited additional training may be required.
2 — Limited skill — Has performed job during training program; additional training is required to develop skill.
1 — Unskilled — Is familiar with process, but is unable to perform job.

REFRIGERATION SYSTEM

JOB SHEET 6

Inspect and replace the evaporator.

STUDENT'S NAME ____________________ DATE ______________

EVALUATOR'S NAME ____________________ ATTEMPT NO. ______

INSTRUCTIONS

When you are ready to perform this task, ask your instructor to observe the procedure and complete this form. All items listed under "Process Evaluation" must receive a "Yes" for you to receive an acceptable performance evaluation.

PROCESS EVALUATION

Evaluator Note: Place a check mark in the "Yes" or "No" blanks to designate whether or not the student has satisfactorily achieved each step in this procedure. If the student is unable to achieve this competency, have the student review the materials and try again.

The student	YES	NO
Procedure 1: Inspected evaporator.		
1. Looked for damaged parts or bolts on evaporator.	_____	_____
2. If anything was damaged, performed procedure 2.	_____	_____
3. Reported to instructor.	_____	_____
Procedure 2: Replaced evaporator.		
1. Located the evaporator.	_____	_____
2. Disconnected the inlet hose.	_____	_____
3. Disconnected the outlet hose.	_____	_____
4. Removed the bolts holding the evaporator to the car.	_____	_____
5. Removed the evaporator from the car.	_____	_____
6. Flushed evaporator.	_____	_____

	YES	NO
7. Placed new evaporator into the car.	_____	_____
8. Inserted bolts into evaporator and mount.	_____	_____
9. Tightened bolts.	_____	_____
10. Reconnected the outlet hose.	_____	_____
11. Reconnected the inlet hose.	_____	_____
12. Reported to instructor.	_____	_____
13. Used proper tools correctly.	_____	_____
14. Performed steps in a timely manner.	_____	_____
15. Practiced safety rules throughout procedure.	_____	_____
16. Provided satisfactory responses to questions asked.	_____	_____
17. Put away tools and equipment and cleaned work area.	_____	_____

EVALUATOR'S COMMENTS ____

____

PRODUCT EVALUATION

Evaluator Note: Rate the student on the following criteria by circling the appropriate numbers. Each criterion must receive a rating of "3" or higher to demonstrate student mastery. (See performance evaluation key.) A student who is unable to demonstrate mastery should review the materials and submit another product for evaluation.

Criteria				
Product meets manufacturer's installation specifications.	4	3	2	1
Product meets manufacturer's adjustment specifications.	4	3	2	1
Product includes proper components/materials.	4	3	2	1
Product appearance meets industry standards.	4	3	2	1

EVALUATOR'S COMMENTS

AVERAGE RATING

Evaluator Note: To obtain an average rating for the competency profile, total the designated points in "Product Evaluation" and divide by the total number of criteria. Circle the rating on the "Performance Evaluation Key" below.

PERFORMANCE EVALUATION KEY

4 — Skilled — Can perform job with no additional training.
3 — Moderately skilled — Has performed job during training program; limited additional training may be required.
2 — Limited skill — Has performed job during training program; additional training is required to develop skill.
1 — Unskilled — Is familiar with process, but is unable to perform job.

PRACTICAL TEST 7

REFRIGERATION SYSTEM

JOB SHEET 7

Inspect and replace the receiver/drier.

STUDENT'S NAME ________________ DATE ____________

EVALUATOR'S NAME ________________ ATTEMPT NO. _____

INSTRUCTIONS

When you are ready to perform this task, ask your instructor to observe the procedure and complete this form. All items listed under "Process Evaluation" must receive a "Yes" for you to receive an acceptable performance evaluation.

PROCESS EVALUATION

Evaluator Note: Place a check mark in the "Yes" or "No" blanks to designate whether or not the student has satisfactorily achieved each step in this procedure. If the student is unable to achieve this competency, have the student review the materials and try again.

The student	YES	NO
Procedure 1: Inspected receiver/drier.		
1. Looked for damaged parts or bolts on receiver/drier.	____	____
2. If anything was damaged, performed procedure 2.	____	____
3. Reported to instructor.	____	____
Procedure 2: Replaced receiver/drier.		
1. Disconnected the inlet hose.	____	____
2. Disconnected the outlet hose.	____	____
3. Removed the bolts holding the receiver/drier to the car.	____	____
4. Removed the receiver/drier from the car.	____	____
5. Placed new receiver/drier into the car.	____	____

	YES	NO
6. Inserted bolts into receiver/drier and mount.	____	____
7. Tightened bolts.	____	____
8. Reconnected the outlet hose.	____	____
9. Reconnected the inlet hose.	____	____
10. Reported to instructor.	____	____
11. Used proper tools correctly.	____	____
12. Performed steps in a timely manner.	____	____
13. Practiced safety rules throughout procedure.	____	____
14. Provided satisfactory responses to questions asked.	____	____
15. Put away tools and equipment and cleaned work area.	____	____

EVALUATOR'S COMMENTS ____

____

PRODUCT EVALUATION

Evaluator Note: Rate the student on the following criteria by circling the appropriate numbers. Each criterion must receive a rating of "3" or higher to demonstrate student mastery. (See performance evaluation key.) A student who is unable to demonstrate mastery should review the materials and submit another product for evaluation.

Criteria				
Product meets manufacturer's installation specifications.	4	3	2	1
Product meets manufacturer's adjustment specifications.	4	3	2	1
Product includes proper components/materials.	4	3	2	1
Product appearance meets industry standards.	4	3	2	1

EVALUATOR'S COMMENTS

____

____

____

AVERAGE RATING

Evaluator Note: To obtain an average rating for the competency profile, total the designated points in "Product Evaluation" and divide by the total number of criteria. Circle the rating on the "Performance Evaluation Key" below.

PERFORMANCE EVALUATION KEY

4 — Skilled — Can perform job with no additional training.
3 — Moderately skilled — Has performed job during training program; limited additional training may be required.
2 — Limited skill — Has performed job during training program; additional training is required to develop skill.
1 — Unskilled — Is familiar with process, but is unable to perform job.

PRACTICAL TEST 8

REFRIGERATION SYSTEM

JOB SHEET 8

Inspect and replace the condenser.

STUDENT'S NAME ____________________ DATE ______________

EVALUATOR'S NAME ____________________ ATTEMPT NO. ______

INSTRUCTIONS

When you are ready to perform this task, ask your instructor to observe the procedure and complete this form. All items listed under "Process Evaluation" must receive a "Yes" for you to receive an acceptable performance evaluation.

PROCESS EVALUATION

Evaluator Note: Place a check mark in the "Yes" or "No" blanks to designate whether or not the student has satisfactorily achieved each step in this procedure. If the student is unable to achieve this competency, have the student review the materials and try again.

The student	YES	NO
Procedure 1: Inspected condenser.		
1. Looked for damaged parts, bolts or bent fins on condenser.	_____	_____
2. Removed leaves, bugs, or other debris on condenser coils.	_____	_____
3. If anything was damaged, performed procedure 2.	_____	_____
4. Reported to instructor.	_____	_____
Procedure 2: Replaced condenser.		
1. Disconnected the inlet hose.	_____	_____
2. Disconnected the outlet hose.	_____	_____
3. Removed the bolts holding the condenser to the car.	_____	_____
4. Removed the condenser from the car.	_____	_____

	YES	NO
5. Flushed condenser.	____	____
6. Placed new condenser into the car.	____	____
7. Inserted bolts into condenser and mount.	____	____
8. Tightened bolts.	____	____
9. Reconnected the outlet hose.	____	____
10. Reconnected the inlet hose.	____	____
11. Reported to instructor.	____	____
12. Used proper tools correctly.	____	____
13. Performed steps in a timely manner.	____	____
14. Practiced safety rules throughout procedure.	____	____
15. Provided satisfactory responses to questions asked.	____	____
16. Put away tools and equipment and cleaned work area.	____	____

EVALUATOR'S COMMENTS ____

____

PRODUCT EVALUATION

Evaluator Note: Rate the student on the following criteria by circling the appropriate numbers. Each criterion must receive a rating of "3" or higher to demonstrate student mastery. (See performance evaluation key.) A student who is unable to demonstrate mastery should review the materials and submit another product for evaluation.

Criteria				
Product meets manufacturer's installation specifications.	4	3	2	1
Product meets manufacturer's adjustment specifications.	4	3	2	1
Product includes proper components/materials.	4	3	2	1
Product appearance meets industry standards.	4	3	2	1

EVALUATOR'S COMMENTS

AVERAGE RATING

Evaluator Note: To obtain an average rating for the competency profile, total the designated points in "Product Evaluation" and divide by the total number of criteria. Circle the rating on the "Performance Evaluation Key" below.

PERFORMANCE EVALUATION KEY

4 — Skilled — Can perform job with no additional training.
3 — Moderately skilled — Has performed job during training program; limited additional training may be required.
2 — Limited skill — Has performed job during training program; additional training is required to develop skill.
1 — Unskilled — Is familiar with process, but is unable to perform job.

PRACTICAL TEST 9

REFRIGERATION SYSTEM

II

JOB SHEET 9

Inspect and replace orifice tube or expansion valve.

STUDENT'S NAME ____________________ DATE ______________

EVALUATOR'S NAME ____________________ ATTEMPT NO. ______

INSTRUCTIONS

When you are ready to perform this task, ask your instructor to observe the procedure and complete this form. All items listed under "Process Evaluation" must receive a "Yes" for you to receive an acceptable performance evaluation.

PROCESS EVALUATION

Evaluator Note: Place a check mark in the "Yes" or "No" blanks to designate whether or not the student has satisfactorily achieved each step in this procedure. If the student is unable to achieve this competency, have the student review the materials and try again.

The student	YES	NO
Procedure 1: Inspected the orifice tube or expansion valve.		
1. Located the orifice tube or expansion valve.	_____	_____
2. Looked for damaged connections or parts.	_____	_____
3. If anything was damaged, reported to instructor.	_____	_____
4. Used proper tools correctly.	_____	_____
5. Performed steps in a timely manner.	_____	_____
6. Practiced safety rules throughout procedure.	_____	_____
7. Provided satisfactory responses to questions asked.	_____	_____
8. Put away tools and equipment and cleaned work area.	_____	_____

Procedure 2: Replaced the orifice tube or expansion valve.

	YES	NO
1. Discharged the system.	_____	_____
2. Disconnected hoses from orifice tube or expansion valve.	_____	_____
3. Removed orifice tube or expansion valve.	_____	_____
4. Rubbed refrigerant oil on new orifice tube or expansion valve.	_____	_____
5. Put new orifice tube or expansion valve in place.	_____	_____
6. Reconnected hoses to orifice tube or expansion valve.	_____	_____
7. Evacuated the system.	_____	_____
8. Charged the system.	_____	_____
9. Used proper tools correctly.	_____	_____
10. Performed steps in a timely manner.	_____	_____
11. Practiced safety rules throughout procedure.	_____	_____
12. Provided satisfactory responses to questions asked.	_____	_____
13. Put away tools and equipment and cleaned work area.	_____	_____

EVALUATOR'S COMMENTS ____

____

PRODUCT EVALUATION

Evaluator Note: Rate the student on the following criteria by circling the appropriate numbers. Each criterion must receive a rating of "3" or higher to demonstrate student mastery. (See performance evaluation key.) A student who is unable to demonstrate mastery should review the materials and submit another product for evaluation.

Criteria				
Product meets manufacturer's installation specifications.	4	3	2	1
Product meets manufacturer's adjustment specifications.	4	3	2	1
Product includes proper components/materials.	4	3	2	1
Product appearance meets industry standards.	4	3	2	1

EVALUATOR'S COMMENTS

AVERAGE RATING

Evaluator Note: To obtain an average rating for the competency profile, total the designated points in "Product Evaluation" and divide by the total number of criteria. Circle the rating on the "Performance Evaluation Key" below.

PERFORMANCE EVALUATION KEY

4 — Skilled — Can perform job with no additional training.
3 — Moderately skilled — Has performed job during training program; limited additional training may be required.
2 — Limited skill — Has performed job during training program; additional training is required to develop skill.
1 — Unskilled — Is familiar with process, but is unable to perform job.

REFRIGERATION SYSTEM

NAME ____________________ SCORE ______

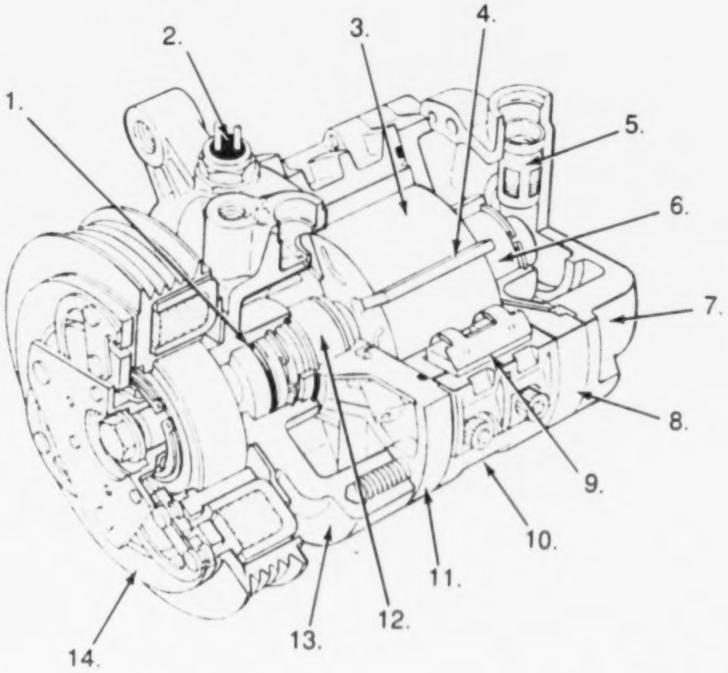
OBJECTIVE 1

State the function of refrigeration system protection devices.

1. **Ambient relay** — ____________________
2. **Low-pressure cutoff switch** — ____________________
3. **Superheat switch** — ____________________
4. **Thermostat control switch** — ____________________
5. **Thermal limiter** — ____________________

OBJECTIVE 2 **Label the types and parts of the compressor.**

FIGURE 1


1.
2.
3.
4.
5.
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9.
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11.
12.
13.
14.

Type: ______________________________

1. ____________________

2. ____________________

3. ____________________

4. ____________________

5. ____________________

6. ____________________

7. ____________________

8. ____________________

9. ____________________

10. ____________________

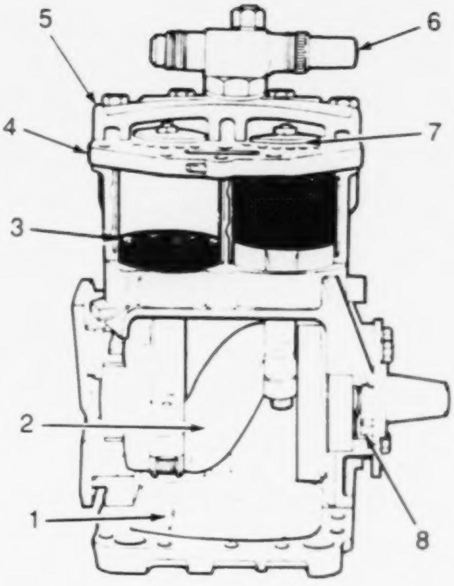
11. ____________________

12. ____________________

13. ____________________

14. ____________________

FIGURE 2



Type: ______________________

1. ______________________

2. ______________________

3. ______________________

4. ______________________

5. ______________________

6. ______________________

7. ______________________

8. ______________________

OBJECTIVE 3

Arrange in order the steps by which a compressor pumps refrigerant through the air conditioning system.

______a. When the vane is 180 degrees from the two ports on the compressor, it begins to move into the rotor.

______b. As the vane moves out, the area between the rotor and the compressor wall increases.

______c. As the vane moves in, the area between the rotor and the compressor wall decreases.

______d. High-pressure refrigerant exits the compressor through the discharge port.

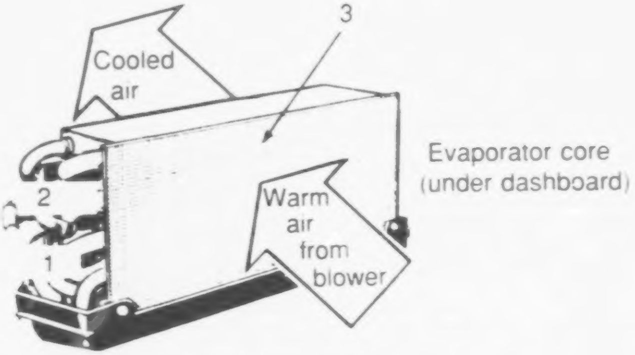
______e. As the area between the rotor and the compressor wall decreases, the refrigerant is compressed.

______f. Refrigerant enters the compressor through the suction port.

______g. As the rotor spins, a vane moves out to stay in contact with the compressor wall.

______h. More refrigerant is sucked into the compressor.

OBJECTIVE 4 **Label the parts of the evaporator.**


3
Cooled air
Evaporator core (under dashboard)
2
Warm air from blower
1

Heat absorbed by evaporator

1. ______________________ 3. ______________________

2. ______________________

OBJECTIVE 5

Arrange in order the steps by which the evaporator changes refrigerant from liquid to gas.

_______a. Air surrounding the coils is cooled by the heat absorption.

_______b. As the cold liquid refrigerant absorbs heat, it changes to hot, low-pressure gas refrigerant.

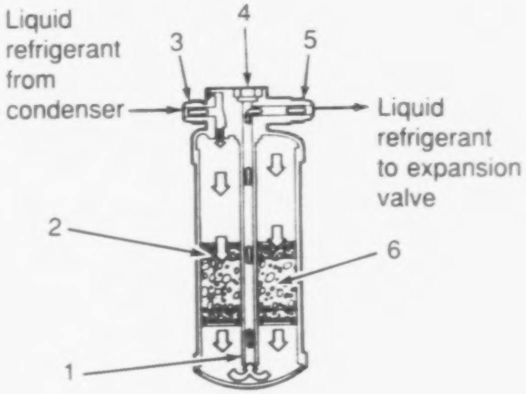
_______c. Liquid refrigerant flows into the evaporator from the expansion valve.

_______d. Gas refrigerant flows out the evaporator to the compressor.

_______e. Cold liquid refrigerant flows through the evaporator coils and absorbs heat surrounding the coils.

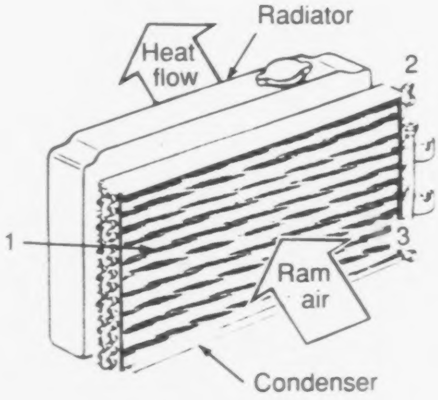
OBJECTIVE 6

Label the parts of the receiver/drier.


Liquid refrigerant from condenser
3
4
5
Liquid refrigerant to expansion valve
2
6
1

1. ______________________
2. ______________________
3. ______________________
4. ______________________
5. ______________________
6. ______________________

OBJECTIVE 7 **Label the parts of the condenser.**


Radiator
Heat flow
2
1
3
Ram air
Condenser

Ram air & heat flow

1. ______________________ 3. ______________________

2. ______________________

OBJECTIVE 8 **State the most important function of the compressor.**

____

____

____

____

____

OBJECTIVE 9

Arrange in order the steps by which the condenser changes refrigerant from gas to liquid.

______a. As the hot gas refrigerant flows through the condenser coils, it releases heat into the air surrounding the condenser.

______b. Hot gas refrigerant is pumped from the compressor toward the condenser.

______c. Hot gas refrigerant flows through the condenser coils.

______d. As the gas refrigerant loses heat, it begins to turn into high-pressure liquid refrigerant.

______e. Hot gas refrigerant enters the top of the condenser.

NOTICE

The following assignment sheet and job sheets are not part of the written test. If these activities have not been completed, check with your instructor.

OBJECTIVE 10	**Diagnose problems.**	SCORE ______
OBJECTIVE 11a	**Flush a component.**	RATING ______
OBJECTIVE 11b	**Inspect and replace a system hose and/or gaskets and O-rings.**	RATING ______
OBJECTIVE 11c	**Inspect protection devices.**	RATING ______
OBJECTIVE 11d	**Inspect and replace the compressor and compressor mounting hardware.**	RATING ______
OBJECTIVE 11e	**Inspect and replace accumulator.**	RATING ______
OBJECTIVE 11f	**Inspect and replace the evaporator.**	RATING ______
OBJECTIVE 11g	**Inspect and replace the receiver/drier.**	RATING ______
OBJECTIVE 11h	**Inspect and replace the condenser.**	RATING ______
OBJECTIVE 11i	**Inspect and replace orifice tube or expansion tube.**	RATING ______

WRITTEN TEST ANSWERS

REFRIGERATION SYSTEM

II

OBJECTIVE 1

1. **Ambient relay** — Prevents the compressor from engaging when the outside temperature falls below 32 degrees Fahrenheit
2. **Low-pressure cutoff switch** — Prevents the compressor from engaging when the refrigerant level is too low
3. **Superheat switch** — Prevents the compressor from engaging when the refrigerant temperature is too high
4. **Thermostat control switch** — Prevents the evaporator from freezing by regulating air discharge temperature
5. **Thermal limiter** — Prevents the compressor from engaging when pressure is too high

OBJECTIVE 2

Figure 1
Type: Rotary

1. Shaft seal assembly
2. Temperature sensor
3. Rotor assembly
4. Vane
5. Check valve
6. Bearing
7. Rear head assembly
8. Rear side block assembly
9. Roll valves
10. Cylinder
11. Front side block assembly
12. Bearing
13. Front head
14. Magnetic clutch assembly

Figure 2
Type: Piston

1. Oil slump
2. Crankshaft
3. Piston and ring assembly
4. Valve plate
5. Cylinder head
6. Servicing valve fitting
7. Reed valve assembly
8. Crankshaft seal assembly

OBJECTIVE 3

a. 5
b. 3
c. 6
d. 8
e. 7
f. 1
g. 2
h. 4

OBJECTIVE 4

1. Inlet
2. Outlet
3. Evaporator coils or core

OBJECTIVE 5

1. c
2. e
3. a
4. b
5. d

OBJECTIVE 6

1. Pickup tube
2. Filter pads
3. Inlet
4. Sight glass
5. Outlet
6. Desiccant

OBJECTIVE 7

1. Condenser coils
2. Inlet
3. Outlet

OBJECTIVE 8

Raise the temperature of refrigerant by putting it under pressure.

OBJECTIVE 9

1. b
2. e
3. c
4. a
5. d

OBJECTIVE 10

Refer to the answers to Assignment Sheet 1.

OBJECTIVE 11

Refer to practical test ratings for Job Sheets 1-9.

OBJECTIVE SHEET

AIR CONDITIONING MECHANICAL AND ELECTRICAL CONTROLS III

INTRODUCTION

Automobile air conditioning and heating systems are vital for passenger comfort. The operator can control the air conditioning and heating systems using both mechanical and electrical controls. These controls consist of levers operated by either the driver or passenger of the car. The levers cause certain doors in the air conditioning system to open or close, controlling the direction and temperature of air flowing into the car.

UNIT OBJECTIVE

After completing this unit, the student should be able to identify the components and functions of mechanical and electrical controls of an air conditioning system. The student should also be able to inspect and replace the components of these controls. The student will demonstrate these competencies by completing assignment sheets, job sheets, and a written test with a minimum of 85 percent accuracy.

PREREQUISITE

Electrical Systems Specialist, Units I and II

SPECIFIC OBJECTIVES

After completing this unit, the student should be able to

1. Match terms associated with air conditioning mechanical and electrical controls to their definitions.
2. Label the parts of the air conditioning mechanical controls.
3. State the functions of the control head assembly switches.
4. Match airflow doors to their functions.
5. Select from a list true statements about a vacuum motor.
6. Identify the vacuum motor working at each position of the function control switch.
7. Identify the electrical controls operating at each position of the function control switch.
8. Diagnose problems in the vacuum lines. (Assignment Sheet 1)
9. Interpret a wiring diagram. (Assignment Sheet 2)
10. Diagnose electrical problems. (Assignment Sheet 3)

11. Demonstrate the ability to:

    a. Inspect and replace a control head assembly. (Job Sheet 1)

    b. Use a vacuum tee and gauge to determine source of lost vacuum in vacuum lines. (Job Sheet 2)

    c. Replace vacuum lines. (Job Sheet 3)

    d. Inspect and replace electrical controls. (Job Sheet 4)

    e. Inspect and replace idle controls. (Job Sheet 5)

    f. Inspect and replace idle speed controls. (Job Sheet 6)

PREPARATION

- Review unit and plan presentation.
- Give Pretest.
- Determine scope and sequence of objectives that you add. Design and develop support materials, including evaluation techniques, for additional objectives.
- Review teaching suggestions and plan classroom activities.
- Determine how you will schedule time for students to demonstrate competence in the required procedures.
- Order materials to supplement unit.
- Invite a local auto mechanic to the class.

DELIVERY

Objective 1 Match terms associated with air conditioning mechanical and electrical controls to their definitions.

- Discuss the term "baffles" in the context of the vacuum reservoir.
- Explain the difference between recirculating air and bringing it in from the outside.

Objective 2 Label the parts of the air conditioning mechanical controls.

- Discuss the different parts of the control head assembly.

Objective 3 State the functions of the control head assembly switches.

- Discuss the importance of each part of the control head assembly.
- Point out how the parts are interrelated.
- Explain that some control head assemblies will differ from the example given.

Objective 4 Match airflow doors to their functions.

- Discuss the importance of the airflow door with regard to controlling the flow of air in the car.
- Point out that the doors are interdependent.
- Begin to introduce the idea of a vacuum motor.

Objective 5 Select from a list true statements about a vacuum motor.

- Show the students the location of the vacuum reservoir.
- Explain to the students how baffles in the vacuum reservoir compensate for losses in vacuum pressure.

Objective 6 Identify the vacuum motor working at each position of the function control switch.

- Stress the similarity between "A/C Max," "A/C Norm," and "Vent."
- Point out that "A/C Norm" is warmer than "A/C Max" because outside air is entering the car.
- Explain that in the vent position, outside air flows into the car, through the dash, and into the passenger compartment.

Objective 7 Identify the electrical controls operating at each position of the function control switch.

- Point out that the only difference between the A/C settings and vent is that the air conditioning compressor is not on.

APPLICATION

Objective 8 Diagnose problems in the vacuum lines. (Assignment Sheet 1)

Objective 9 Interpret a wiring diagram. (Assignment Sheet 2)

Objective 10 Diagnose electrical problems. (Assignment Sheet 3)

- Use assignment sheets 1-3 to help students diagnose electrical and mechanical problems.

Objective 11 Demonstrate the ability to:

- Inspect and replace a control head assembly. (Job Sheet 1)
- Use a vacuum in vacuum lines. (Job Sheet 2)
- Replace vacuum lines. (Job Sheet 3)
- Inspect and replace electrical controls. (Job Sheet 4)
- Inspect and replace idle controls. (Job Sheet 5)
- Inspect and replace idle speed controls. (Job Sheet 6)
- Use the job sheets to help students perform basic maintenance.

EVALUATION

Pretest

- Pretest qualifying students.
- Determine individual requirements from pretest results.
- Counsel students individually on pretest results and study requirements.

Practical Test

- Explain to students that they will be asked to demonstrate procedures on the job sheets to complete the practical test.
- Describe the rating scale used on the practical test.
- Reteach and retest as necessary.

Written Test

- Explain to students that they will be asked to demonstrate on the written test actions listed in the specific objectives.
- Give written test.

  NOTE: The written test may be given in sections if desired.

- Evaluate students on assignment sheet activities if not previously done.

- Reteach and retest if necessary.

- Complete appropriate section of competency profiles.

- Review individual and group performance in order to evaluate teaching methods. Adjust scope, sequence, or instructional approaches for additional lessons as required.

SUGGESTED RESOURCES

Publications

- *Auto Mechanics*, by Jay Webster. Glencoe/McGraw-Hill, 2nd edition. Covers automobile air conditioning and heating for entry-level vocational training. Activity Guide and Instructor's Manual and Key available. Call 1-800-423-9534.

- *Automotive Air Conditioning and Heating*, by Ivan Hinerman and Tom Birch. Provides in-depth text and procedures for troubleshooting and service. From Glencoe Publishing Company, Mission Hills, California, telephone 1-800-257-5755.

- *Chilton's Guide to Air Conditioning Repair and Service*. Basic procedures for diagnosis, service, and repair; vacuum and wiring schematics on A/C systems in 1982-85 domestic cars, light trucks and popular imports. Order No. IBN 0-8019-s7580-8. Call Chilton Book Company, School and Library Division, 1-800-345-1214, extension 4729.

- *Fundamentals of Air Conditioning*, General Motors course materials; instructor and student manuals. Includes operation, diagnosis, purging, leak and performance testing; 67 overhead transparencies. Telephone 1-800-468-6657.

- *Air Conditioning*, Chrysler Motors Service Publication on principles, operation, components, function, diagnoses and controls for Chryslers through 1988. Student Reference Book order No. 81-699-8031. Audiotape and videotape support available. Write to Chrysler Motors Service Training, 26001 Lawrence Avenue, Center Line, Michigan 48015.

- *Automotive Air Conditioning and Heating* 0-02-818620-6 — Glencoe Publishing Company, 1-800-257-5775.

- *Automotive Air Conditioning* 014857-0 — McGraw-Hill Publishing Company, 1-800-334-7344.

Audiovisual materials

- *Air Conditioning Compressor Seal Service.* OL. MI-8011V-TTS. Available from Career Aids Division. 20417 Nordhoff St., Dept. R 4 5. Chatsworth. CA 91311.

- *Air Conditioning Diagnosis.* OL. MI-8009V-TTS. Available from Career Aids Division. 20417 Nordhoff St., Dept. R 4 5. Chatsworth. CA 91311.

- *Air Conditioning Performance Testing.* Chrysler Corporation. M-8671. Available from ASA. P.O. Box 1047. Bedford. TX 76095.

- *Air Conditioning System.* Ford Parts and Service Division. M-8001. Available from ASA. P.O. Box 1047. Bedford. TX 76095.

- *Automotive Air Conditioning Explained.* B-442X. Available from Teaching Aids. Inc., P.O. Box 1798. Costa Mesa. CA 92628.

- *Automotive Air Conditioning Service.* OL. MI-8008V-TTS. Available from Career Aids Division. 20417. Nordhoff St., Dept R 4 5. Chatsworth. CA 91311.

- *The Automotive Air Conditioner.* Set of 3 VHS cassettes. VHS 1. *Basic Parts and Principles* (17:52 min) addresses principles of air conditioning and identifies components and their functions. Demonstrates flow of freon through the system. VHS 2. *Using the Equipment.* (18:00 min) covers major equipment and tools used in air conditioning maintenance and repair; shows procedures for checking pressure. using freon. finding freon leaks. VHS 3. *Troubleshooting Problems.* (14:02 min) shows students how to detect freon leaks. how to troubleshoot. and how to correct problems. Videotapes can be purchased separately. Available from Bergwall Video Productions. Inc., 1-800-645-3565.

- *The Automotive Cooling System.* 406X-V11. Available from Bergwall Productions. Inc., P.O. Box 238. Garden City. NY 11530.

- *Basic Air Conditioning Systems.* OL. MI-8010V-TTS. Available from Career Aids Division, 20417 Nordhoff St., Dept. R 4 5, Chatsworth, CA 91311.
- *Discharge and Evaluation.* R-AB138. Available from Teaching Aids, Inc., P.O. Box 1798, Costa Mesa, CA 92628.
- *Draining the Cooling System.* OL. 010-486-TTS. Available from Career Aids Division, 20417 Nordhoff St., Dept. R 4 5, Chatsworth, CA 91311.
- *Heating and Air Conditioning.* Ford Parts and Service Division M-8669. Available from ASA, P.O. Box 1047, Bedford, TX 76095.
- *Keep Your Car Cool.* MO-706. Available from Teaching Aids, Inc., P.O. Box 1798, Costa Mesa, CA 92628.
- *Principles of Climate Control Air Distribution (Car and Light Truck).* ½" VHS, color, (45:56 min). Covers basics of refrigeration and heat transfer. Shows components and discusses functions; covers electrical system as related to heat and air conditioning. Order No: 3640-006A. Available from Ford Service Publications, P.O. Box 07150, Detroit, MI 48207. To place credit card orders, call 1-800-782-4356.
- *Recharge System.* R-AB139. Available from Teaching Aids, Inc., P.O. Box 1798, Costa Mesa, CA 92628.
- *Refilling the Cooling System.* OL. 010-486-TTS. Available from Career Aids Division, 20417 Nordhoff St., Dept R 4 5, Chatsworth, CA 91311.

NOTE: These films are available to Oklahoma teachers on a free-loan basis. Oklahoma teachers may order these films from the Curriculum Instructional Materials Center, Oklahoma Department of Vocational and Technical Education, 1500 W. Seventh, Stillwater, OK 74074. Out-of-state teachers must order these films direct from the company.

UNIT REFERENCES

- *Chevrolet Service Manual.* General Motors, 1988.
- Crouse, William H. and Anglin, Donald L. *Automotive Mechanics.* New York, McGraw-Hill Book Company, 1981.

- Mitchell Information Services, Inc., *Mitchell Automechanics*. New Jersey, Prentice Hall, 1982.

PRETEST ANSWERS

AIR CONDITIONING MECHANICAL AND ELECTRICAL CONTROLS — *III*

EVALUATOR NOTE

Use the following answer key to check student answers to pretest questions. To determine the student's individual study requirements from pretest results, use the following table, which shows the correlation between the objectives and pretest questions. Counsel the students individually on pretest results and study requirements.

TABLE

Correlation between objective and pretest questions

Objective	Question(s)
1	1, 2, 3
2	4, 5
3	6, 7
4	8, 9
5	10, 11
6	12, 13, 14, 15, 16, 17
7	18, 19, 20, 21
8	22
9	23
10	24
11	25, 26, 27, 28

ANSWER KEY

1. a
2. b
3. c
4. b
5. a
6. c
7. b
8. a
9. a
10. c
11. b
12. a
13. b
14. c
15. c
16. a
17. a
18. b
19. c
20. c
21. b
22. a
23. d
24. a
25. c
26. b
27. b
28. a

PRETEST

AIR CONDITION MECHANICAL AND ELECTRICAL CONTROLS

III

NAME ______________________________ SCORE ______

DIRECTIONS

Read the following questions and problems. Select the item that best answers the question or problem, and write the correct letter in the blank.

OBJECTIVE 1

______1. The term that means to take air from inside the car, heat or cool it, and move it back into the car is ___.

a. recirculation
b. ventilation
c. baffle

______2. Which of the following best defines ventilation?

a. To put vents in a car
b. To provide air
c. To go in and out in a circle

______3. The vacuum reservoir ___.

a. maintains equal pressure in all vacuum lines operating during a given function
b. prevents the loss of vacuum during acceleration
c. evens out fluctuations in vacuum pressure when engine speed increases and decreases

OBJECTIVE 2

______4. Which of the following lists contains parts of the control head assembly only?

a. Function control switch, temperature control switch, vacuum motor
b. Function control switch, temperature control switch, fan speed switch
c. Fan speed switch, temperature control switch, vacuum motor

______5. Which of the following lists names airflow doors?

a. Recirculation, panel, temperature control
b. Defrost, vacuum, temperature control
c. Panel, temperature control, vacuum

OBJECTIVE 3

______6. Which of the following best defines fan speed switch?

a. A switch connected to a cable that causes the fan speed to increase or decrease
b. An electrical switch that causes the air conditioning speed to increase or decrease
c. An electrical switch that causes the fan speed to increase or decrease

______7. Which of the following best defines temperature control switch?

a. A lever connected by a vacuum line to the temperature control door
b. A lever connected by a cable to the temperature control door
c. A lever connected by a cable to the heater

OBJECTIVE 4

______8. Which of the following allows outside air into the car?

a. Recirculation airflow door
b. Outside airflow door
c. Panel airflow door

______9. The temperature control airflow door allows ___.

a. warm air from the heater and air conditioner to mix with air flowing into the car
b. hot air from the engine manifold to mix with air flowing into the car
c. cold air from heater and air conditioning to mix with air flowing into the car

OBJECTIVE 5

_____10. Which of the following actually opens the panel airflow door?

a. An electrical motor
b. A cable
c. A vacuum motor

_____11. Engine manifold vacuum fluctuates because ___.

a. it will occasionally let air leak in
b. the engine changes speed during acceleration/deceleration
c. exhaust going out of the car causes vacuum loss

OBJECTIVE 6

_____12. When the function control switch is set to "Off," the ___.

a. recirculate vacuum motor is on
b. floor/defrost vacuum motor is off
c. temperature airflow door vacuum motor is on

_____13. When the function control switch is set to "A/C Max," the ___.

a. recirculate vacuum motor is off
b. panel vacuum motor is on
c. floor/defrost vacuum motor is off

_____14. When the function control switch is set to "A/C Norm," the ___.

a. panel vacuum motor is off
b. floor/defrost vacuum motor is off
c. recirculation vacuum motor is off

_____15. When the function control switch is set to "A/C Norm," the ___.

a. temperature control vacuum motor is on
b. temperature control vacuum motor is off
c. panel vacuum motor is on

_____16. When the function control switch is set to "Vent," the ___.

a. recirculation vacuum motor is off
b. temperature control vacuum motor is on
c. panel vacuum motor is off

_____17. When the function control switch is set to "Vent," the ___.

a. recirculation vacuum motor is on
b. temperature control vacuum motor is on
c. temperature control vacuum motor is off

OBJECTIVE 7

_____18. When the function control switch is set to "Off," ___.

a. the fan control is on to allow some air to flow through the dash vents
b. no electrical controls are on
c. electrical controls can still be operated

_____19. When the function control switch is set to "A/C Max," the ___.

a. compressor must be turned on manually
b. fan control must be turned on manually
c. fan control is on

_____20. When the function control switch is set to "A/C Norm," the ___.

a. compressor must be turned on manually
b. fan control must be turned on manually
c. fan control is on

_____21. When the function control switch is set to "Vent," the ___.

a. compressor can be turned on to cool the air
b. compressor is off
c. fan control must be turned on manually

OBJECTIVE 8

_____22. Upon inspecting a customer's vacuum lines, you find one that is cracked. You should ___.

a. replace the cracked portion with a plastic tube
b. replace the entire vacuum line
c. use a tee and gauge to check the pressure

OBJECTIVE 9

_____23. Wiring diagrams give information about ___.

a. wire connection points
b. size of wires
c. color of wires
d. all of the above

OBJECTIVE 10

_____24. If one electrical system is not working (and all others are), the problem can be in any of the following EXCEPT ___.

a. the battery
b. a fuse
c. a solenoid

OBJECTIVE 11

_____25. When using a vacuum and tee inserted between the engine manifold and vacuum reservoir, you must read the gauge when the function control switch is set to ___.

a. the position that has the problem
b. off
c. each position possible

_____26. You are checking for leaks in a car's vacuum lines by using a tee and gauge. You have inserted the tee and gauge in a line that is showing a problem. The gauge reads below normal at that position of the function control switch. You now should ___.

a. check the vacuum reservoir
b. check the line for cracks and bad connections
c. insert the tee and gauge between the vacuum reservoir and the engine manifold

_____27. When inspecting an electrical control, the ___.

a. battery is disconnected first
b. ohmmeter is connected after inspecting wires
c. ohmmeter is connected before the battery is disconnected

_____28. If idle controls need to be replaced, ___.

a. a new solenoid must be attached to the carburetor
b. the idle controls must be cleaned first
c. a new solenoid must be attached to the compressor

INFORMATION SHEET

AIR CONDITIONING MECHANICAL AND ELECTRICAL CONTROLS III

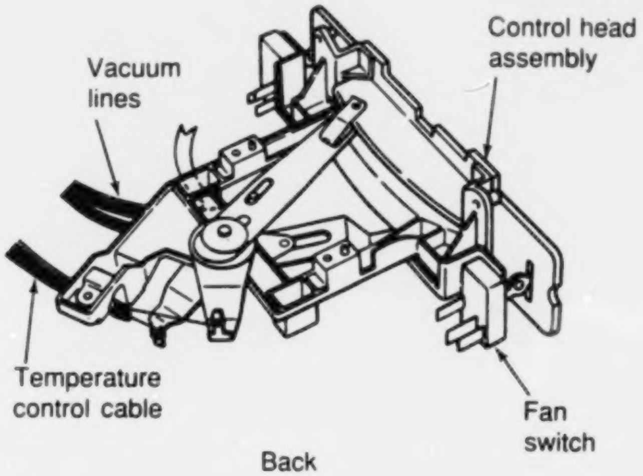
OBJECTIVE 1

Match terms associated with air conditioning mechanical and electrical controls to their definitions.

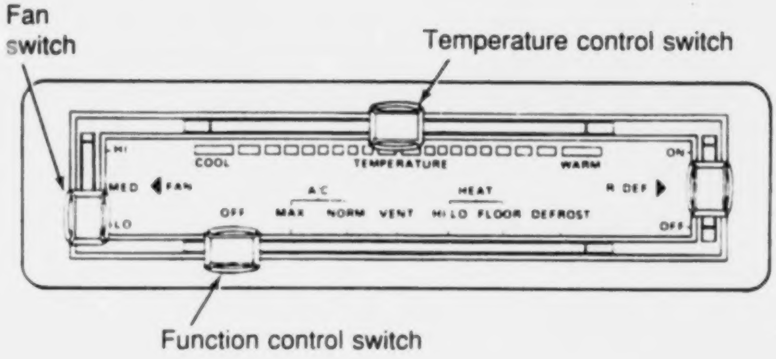
- **Check valve** — Prevents loss of vacuum to the vacuum reservoir during acceleration
- **Recirculation** — To take air from the car, cool or heat it, and move it back into the car
- **Vacuum reservoir** — Evens out fluctuations in vacuum pressure when engine speed increases and decreases
- **Ventilation** — To provide air

OBJECTIVE 2 **Label the parts of the air conditioning mechanical controls.**

Control Head Assembly


Control head assembly
Vacuum lines
Temperature control cable
Fan switch

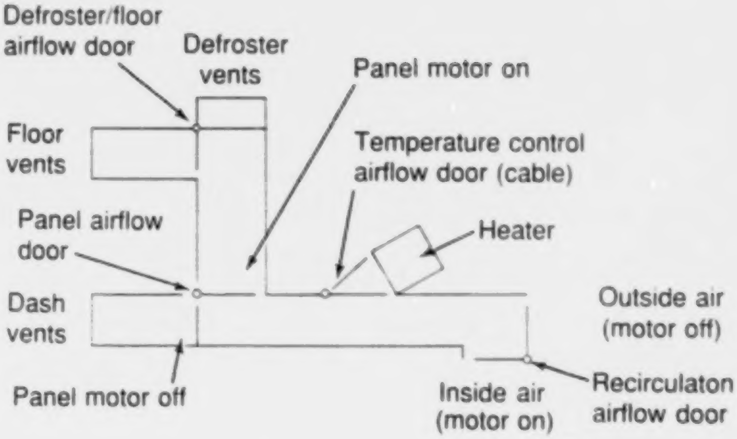
Back


Fan switch
Temperature control switch
HI
MED
LO
FAN
COOL
TEMPERATURE
WARM
A/C
HEAT
OFF
MAX
NORM
VENT
HI-LO
FLOOR
DEFROST
DEF
ON
OFF
Function control switch

Front

NOTE: Notice how the control head assembly houses the function control switch, temperature control switch, and fan speed switch. All vacuum lines and the temperature control cable connect to the control head assembly.

Airflow Doors


Defroster/floor airflow door
Defroster vents
Panel motor on
Floor vents
Temperature control airflow door (cable)
Panel airflow door
Heater
Dash vents
Outside air (motor off)
Panel motor off
Inside air (motor on)
Recirculaton airflow door

Airflow doors

OBJECTIVE 3 **State the functions of the control head assembly switches.**

- **Fan speed switch** — An electrical switch that causes the ventilation system fan to increase or decrease

- **Function control switch** — A lever that operates different airflow doors and electrical devices in order to allow the operator to control the ventilation system

- **Temperature control switch** — A lever connected by cable to the temperature control airflow door that allows the operator to change the temperature of the air

OBJECTIVE 4 **Match airflow doors to their functions.**

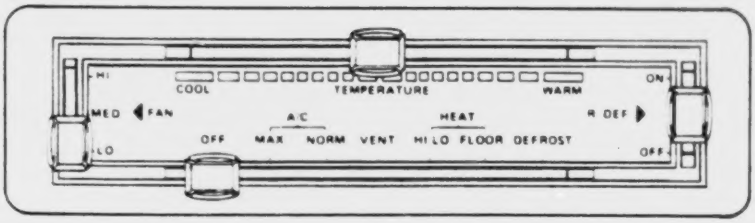
- **Defroster/floor airflow door** — Directs airflow to the defroster vents or floor vents
- **Panel airflow door** — Directs airflow to the defroster/floor airflow door or to the dash vents
- **Recirculation airflow door** — Closes in order to keep outside air from entering the car and opens to allow outside air into the car
- **Temperature control airflow door** — Allows warm air from the heater and air conditioner to mix with air flowing through the ventilation system

OBJECTIVE 5 **Select from a list true statements about a vacuum motor.**

- The vacuum motor allows the operator to control the airflow in the car by moving the function control switch.
- The recirculation, panel, and defroster/floor airflow doors each have a vacuum motor attached.
- The function control switch opens a connection between vacuum lines from the vacuum motor to the engine manifold.
- The engine manifold pulls on the vacuum motor, which in turn pulls on and opens the airflow door.

OBJECTIVE 6

Identify the vacuum motor working at each position of the function control switch.

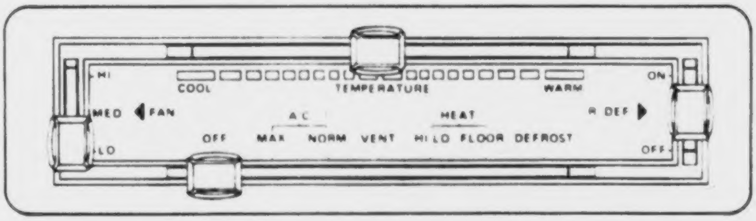

HI
COOL
TEMPERATURE
WARM
ON
MED
FAN
A/C
HEAT
R DEF
OFF
MAX
NORM
VENT
HI LO
FLOOR
DEFROST
LO
OFF

VACUUM MOTORS

Function control switch	Recircu-lation	Panel	Defroster/ floor
1. Off	X		X
2. A/C Max	X	X	X
3. A/C Norm		X	X
4. Vent		X	X

NOTE: An "X" in the blank means the vacuum motor is on.

OBJECTIVE 7 **Identify the electrical controls operating at each position of the function control switch.**


HI
MED
LO
FAN
COOL
TEMPERATURE
WARM
A C
HEAT
OFF
MAX
NORM
VENT
HI LO
FLOOR
DEFROST
R DEF
ON
OFF

ELECTRICAL CONTROLS

Function control switch	Air compressor	Fan speed switch
1. Off	____	____
2. A/C Max	X	X
3. A/C Norm	X	X
4. Vent	____	____

NOTE: An "X" in the blank means the electrical control is on.

ACTIVITY SHEET 1

AIR CONDITIONING MECHANICAL AND ELECTRICAL CONTROLS III

NAME ______________________________

COMPARE AUTO ELECTRICAL SYSTEMS TO HOUSEHOLD ELECTRICITY

Auto electricity is 12 volt DC (direct current). Household electricity is 120 volt AC (alternating current). What is the difference? Which is more dangerous? Describe how a single circuit in your house operates.

ASSIGNMENT SHEET 1

AIR CONDITIONING MECHANICAL AND ELECTRICAL CONTROLS III

NAME ______________________________ SCORE ________

OBJECTIVE 8 **Diagnose problems in the vacuum lines.**

NOTE: Before any work can be done on a car with a ventilation system problem, the problem must be located. This assignment sheet will help the student diagnose problems in the vacuum lines. Job Sheets 1-3 must be completed before attempting this assignment sheet.

INTRODUCTION Although the location of the control head, airflow doors, and vacuum lines may differ among cars, all cars will have a similar system. A lack of airflow out the defroster will almost always be associated with the defroster/floor airflow door, its vacuum motor, or the vacuum line to the vacuum motor.

DIRECTIONS Each of the statements below describes a problem in the air conditioning system. Read the statement carefully. Write the correct letter in each blank.

______1. Your customer complains that the temperature control switch does not work. The most likely cause is a ___.

   a. leak in the vacuum line to the airflow door
   b. problem with the cable to the airflow door
   c. bad vacuum reservoir

______2. Upon inspecting a customer's vacuum lines, you find one that is cracked. You should ___.

   a. replace the cracked portion with a plastic tube
   b. replace the entire vacuum line
   c. use a tee and gauge to check the pressure

______3. You are test driving a customer's car. You notice that at any position of the function control switch, no air flows out the dash air vents. The problem most likely is in the ___.

   a. vacuum line to the panel airflow doors
   b. vacuum line to the vent function control switch
   c. cable to the recirculation airflow door

______4. You are checking for leaks in a car's vacuum lines by using a tee and gauge. You have inserted the tee and gauge before the vacuum reservoir. The gauge reads below normal at all positions of the function control switch. You now know that ___.

a. vacuum is being lost in the lines
b. vacuum is being lost in the supply line
c. you must first use the tee and gauge at the vacuum reservoir

______5. You are still working on the car described in #4. Now, however, the gauge reads normal at all positions of the function control switch. You now know that ___.

a. vacuum is being lost in the lines
b. vacuum is being lost in the supply line
c. you must first use the tee and gauge at the vacuum reservoir

ASSIGNMENT SHEET 2

AIR CONDITIONING MECHANICAL AND ELECTRICAL CONTROLS

III

NAME ______________________________ SCORE ________

OBJECTIVE 9 **Interpret a wiring diagram.**

INTRODUCTION Wiring diagrams are important tools when working on air conditioning electrical controls. A technician may know the electrical circuit has a problem, but the circuit must be located before work can begin. The wiring diagram gives the technician information such as system voltage, color of wires, and wire connection points.

DIRECTIONS Carefully read each statement below. Use the wiring diagram to decide if each statement is true or false. Write an "X" before each true statement.

______1. The wire connecting the control head to the fan speed switch is red/orange.

______2. The wire grounding the fan speed switch is black.

______3. The wire connecting the fan speed switch to the blower resistors is orange/black.

______4. The fan speed switch has three possible settings.

______5. The wire connecting the control head to the blower motor is brown/orange.

______6. The fan speed switch has four possible settings.

ASSIGNMENT SHEET 3

AIR CONDITIONING MECHANICAL AND ELECTRICAL CONTROLS III

NAME ______________________________ SCORE ________

OBJECTIVE 10 **Diagnose electrical problems.**

INTRODUCTION Electrical problems are difficult to locate and hard to repair. The art of finding an electrical problem is in identifying the bad circuit. The only way to find it is to test the parts connected to it.

DIRECTIONS For each of the situations below, use the following table to choose the best answer. Write the correct letter in each blank.

EFFECT	PROBLEM
Blower runs in high speed at any position of the fan speed switch	Resistors
No cold air coming from vents when A/C is on	Compressor fuse Undercharged system Compressor solenoid
Blower runs in high speed when ignition switch is turned off	Relay
Car is sluggish when A/C is on	Idle solenoid

______1. Mr. Dexter brings his car to you. You notice that the fan works but does not change speeds. The problem is in the ___.

- a. resistors
- b. fan wires
- c. fan fuse

______2. A customer's car is fully charged, yet no cold air comes from the vents. You check the compressor itself, as well as the fuse leading to it. You find these are fine. The problem must be in the ___.

- a. fan speed electrical circuit
- b. evaporator electrical circuit
- c. compressor solenoid

______3. When working on a customer's car, you notice the blower runs even when you turn off the ignition. The problem is in the ___.

a. fuse
b. relay
c. resistors

______4. Mrs. Rodriguez complains that her car is excessively sluggish when the A/C is on. The problem is in the ___.

a. fan solenoid
b. compressor solenoid
c. idle solenoid

ASSIGNMENT ANSWERS

AIR CONDITIONING MECHANICAL AND ELECTRICAL CONTROLS

III

ASSIGNMENT SHEET 1

1. b
2. a
3. a
4. c
5. a

ASSIGNMENT SHEET 2

2, 3, 5, 6

ASSIGNMENT SHEET 3

1. a
2. c
3. b
4. c

JOB SHEET 1

AIR CONDITIONING MECHANICAL AND ELECTRICAL CONTROLS

III

OBJECTIVE 11a

Inspect and replace a control head assembly.

TOOLS AND EQUIPMENT

- Eye protection
- Proper tools as specified by service manual
- Screwdriver
- Wrench
- New control head assembly
- Service manual

CAUTION
Always check the procedure in the vehicle's service manual before beginning any service or repair.

PROCEDURE

1. Perform a visual check of the control head.

2. Disconnect the power source.

3. Locate control head assembly in dash.

4. Note the color code of each vacuum line and attachment pin. Disconnect vacuum lines from control head by removing the clip (if any) and pulling it from the attachment pin.

   NOTE: In some cars, the vacuum lines will be attached to a common disk. You can remove all the vacuum lines by removing this disk. Note how the disk is connected to the control head assembly so you will be able to reattach it correctly.

5. Remove temperature door cable from control head by removing the clip and disconnecting the cable.

6. Disconnect any electrical wires, noting where they are attached so you will be able to reattach them correctly.

7. Remove screws connecting control head to dash.

   NOTE: In some cars, the control head assembly is connected to the dash with clips, not screws. Refer to the manual for your car.

8. Lift control head from dash.

9. Insert new control head.

10. Replace screws connecting control head to dash.

    NOTE: In cars with clips, skip this step.

11. Reconnect electrical wires to their appropriate points.

12. Reconnect temperature door cable.

13. Reconnect vacuum lines to their appropriate connection pins.

    NOTE: In cars with the common attachment disk, reconnect the disk.

14. Have your instructor check your work.

15. Reconnect power source.

16. Test all settings of the function control switch.

17. Have your instructor check your work.

18. Put away tools and equipment and clean the work area.

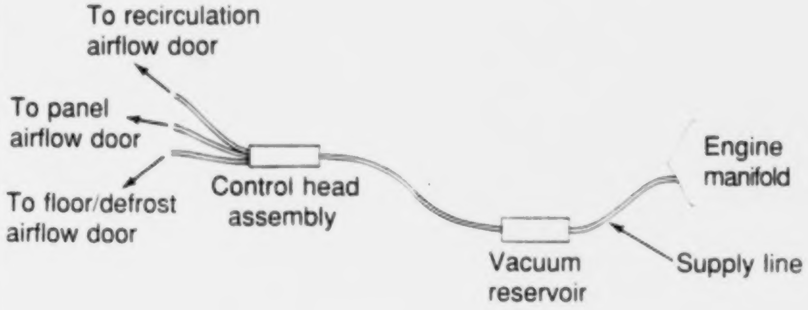
JOB SHEET 2

AIR CONDITIONING MECHANICAL AND ELECTRICAL CONTROLS

III

OBJECTIVE 11b

Use a vacuum tee and gauge to determine source of lost vacuum in vacuum lines.


To recirculation airflow door
To panel airflow door
To floor/defrost airflow door
Control head assembly
Vacuum reservoir
Engine manifold
Supply line

TOOLS AND EQUIPMENT

- Vacuum tee and gauge
- Service manual
- Eye protection

CAUTION

Always check the procedure in the vehicle's service manual before beginning any service or repair.

PROCEDURE

1. Insert vacuum tee in the larger vacuum supply line before the vacuum reservoir.
2. Start car.

3. Have another person move the function control swtich to all possible positions. ("A/C Max," "A/C Norm," "Vent," etc.)

4. Read the gauge at all positions of the function control switch.

5. Refer to the following possible outcomes in order to know where vacuum is being lost.

   - If the gauge reads normal at all positions of the function control switch, vacuum is being lost in the lines.

   - If the gauge reads normal at some positions of the function control switch, vacuum is being lost in lines active at that position of the function control switch.

   - If the gauge reads below normal at all positions of the function control switch, move the tee and gauge past the vacuum reservoir.

   - If the gauge reads below normal at the vacuum reservoir, vacuum is being lost in the supply line. If the gauge reads normal, vacuum is being lost in the lines after the vacuum reservoir.

6. Report the source of lost vacuum to your instructor.

7. Put away tools and equipment and clean the work area.

JOB SHEET 3

AIR CONDITIONING MECHANICAL AND ELECTRICAL CONTROLS

OBJECTIVE 11c

Replace vacuum lines.

TOOLS AND EQUIPMENT

- Eye protection
- Knife
- Neoprene tubing the same diameter as vacuum lines
- Pliers
- Service manual

> **CAUTION**
> **Always** check the procedure in the vehicle's service manual before beginning any service or repair.

PROCEDURE

1. Locate the vacuum line which is the source of lost vacuum. (See Job Sheet 2.)
2. Check the entire line for cracks or bad connections that may be causing the system to lose vacuum.
3. Remove the damaged vacuum line.
4. Use the knife to cut a new vacuum line about ½ inch longer than the section removed.
5. Replace bad section of vacuum line from fitting to fitting.
6. Have your instructor check your work.
7. Put away tools and equipment and clean the work area.

JOB SHEET 4

AIR CONDITIONING MECHANICAL AND ELECTRICAL CONTROLS

OBJECTIVE 11d **Inspect and replace electrical controls.**

TOOLS AND EQUIPMENT

- Eye protection
- Schematic of air conditioning electrical system
- Volt ohmmeter (VOM)
- Screwdriver
- Service manual

> **CAUTION**
> **Always** check the procedure in the vehicle's service manual before beginning any service or repair.

PROCEDURE 1 **Inspect electrical controls.**

1. Locate the electrical control to be inspected. (See service manual.)
2. Check wires for split casing.
3. Check wire attachments to the electrical control for solid connections.
4. Attach VOM to electrical control.
5. Compare reading on VOM to service manual specification.
6. If any wires or connections are bad, report them to your instructor.
7. If the VOM reading differs from the service manual specification, perform procedure 2.
8. Put away tools and equipment and clean work area.

PROCEDURE 2 **Replace electrical controls.**

1. Disconnect the power source.
2. Note the plug connection position.

3. Disconnect the electrical plug from the electrical control.

4. Remove the electrical control from its mounting hardware.

5. Place the new electrical control in mounting hardware.

6. Reconnect electrical plug.

CAUTION

Be sure to connect the wires to the correct terminal on the electrical controls.

7. Have your instructor check your work.

8. Reconnect the power source.

9. Have your instructor check your work.

10. Put away tools and equipment and clean the work area.

JOB SHEET 5 — AIR CONDITIONING MECHANICAL AND ELECTRICAL CONTROLS — III

OBJECTIVE 11e **Inspect and replace idle controls.**

TOOLS AND EQUIPMENT

- Eye protection
- Volt ohmmeter (VOM)
- Wrenches
- New solenoid
- Screwdriver
- Service manual

> **CAUTION**
>
> **Always** check the procedure in the vehicle's service manual before beginning any service or repair.

PROCEDURE 1 **Inspect idle controls.**

1. Locate the idle solenoid on the carburetor. (See service manual.)
2. Check wires for split casing.
3. Check wire attachments to the solenoid for solid connections.
4. Attach VOM to solenoid.
5. Compare reading on VOM to service manual specification.
6. If any wires or connections are bad, report them to your instructor.
7. If the VOM reading differs from the service manual specification, perform procedure 2.
8. Put away tools and equipment and clean work area.

PROCEDURE 2 **Replace idle controls.**

1. Disconnect the power source.
2. Note the plug connector position.

3. Disconnect plug from the solenoid.
4. Remove the solenoid from the carburetor.
5. Attach new solenoid on carburetor.
6. Reconnect plug.

CAUTION

Be sure to connect the wires to the correct terminal on the solenoid.

7. Have your instructor check your work.
8. Reconnect the power source.
9. Start the engine.
10. Turn on the air conditioning.
11. Adjust the idle speed of the engine to the service manual's specification.
12. Have your instructor check your work.
13. Put away tools and equipment and clean the work area.

JOB SHEET 6

AIR CONDITIONING MECHANICAL AND ELECTRICAL CONTROLS

III

OBJECTIVE 11f

Inspect and replace idle speed controls.

TOOLS AND EQUIPMENT

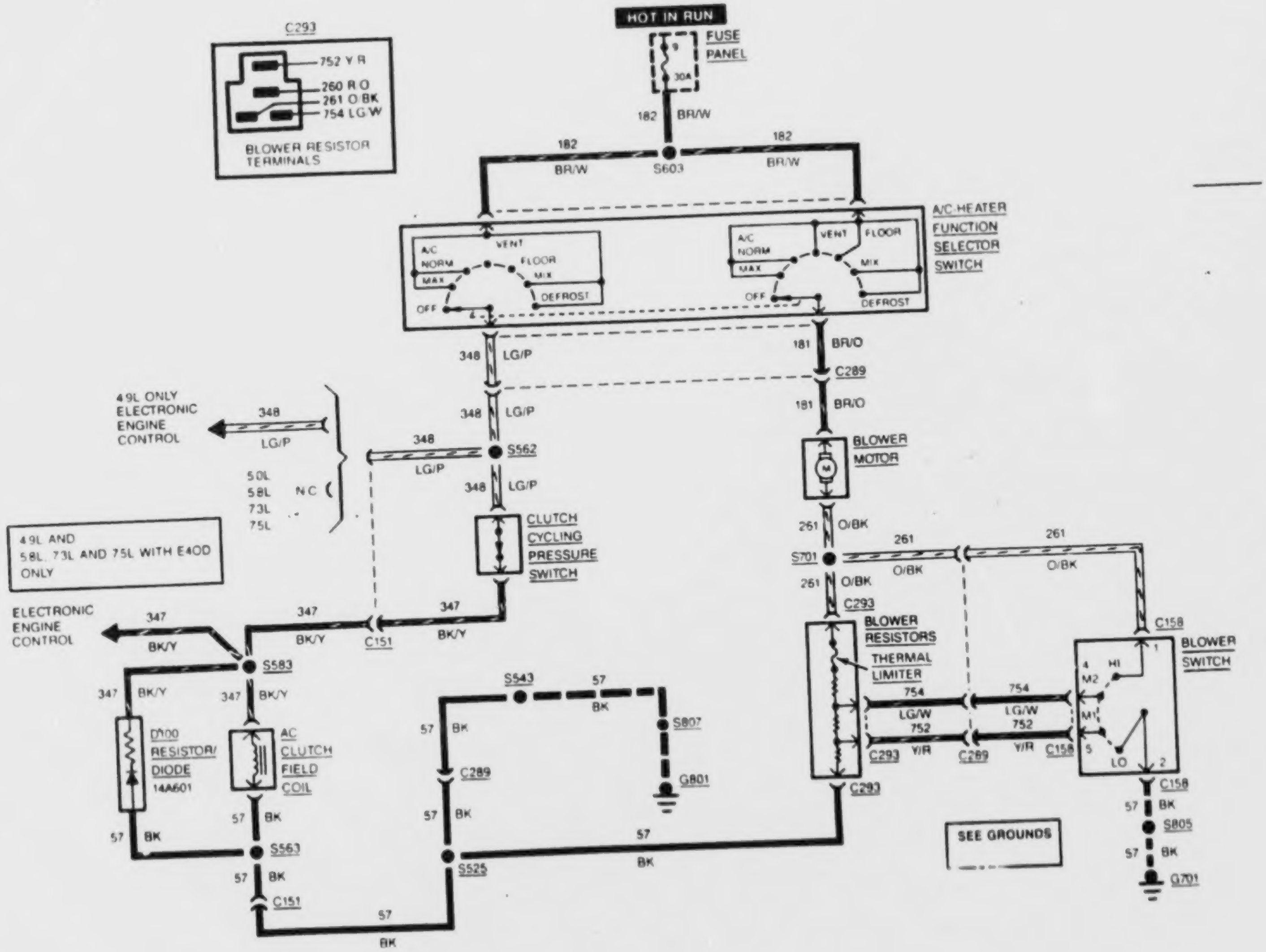
- Eye protection
- Volt ohmmeter (VOM)
- Electronic test equipment
- New control computer (if needed)
- Screwdriver
- Service manual

CAUTION

Always check the procedure in the vehicle's service manual before beginning any service or repair.

PROCEDURE

1. Refer to vehicle manufacturer's manual for proper inspection and replacement.
2. Have your instructor check your work.
3. Put away tools and equipment and clean the work area.


C293
752 Y/R
260 R/O
261 O/BK
754 LG/W
BLOWER RESISTOR TERMINALS
HOT IN RUN
FUSE PANEL
9
30A
182 BR/W
182
BR/W
S603
A/C HEATER FUNCTION SELECTOR SWITCH
A/C
NORM
MAX
OFF
VENT
FLOOR
MIX
DEFROST
348 LG/P
181 BR/O
C289
4.9L ONLY ELECTRONIC ENGINE CONTROL
S562
5.0L
5.8L
7.3L
7.5L
N.C.
BLOWER MOTOR
M
CLUTCH CYCLING PRESSURE SWITCH
261 O/BK
S701
4.9L AND 5.8L, 7.3L AND 7.5L WITH E4OD ONLY
ELECTRONIC ENGINE CONTROL
347 BK/Y
C151
S583
BLOWER RESISTORS
THERMAL LIMITER
C158
BLOWER SWITCH
HI
M2
M1
LO
754 LG/W
752 Y/R
D100 RESISTOR/DIODE 14A601
AC CLUTCH FIELD COIL
S543
57 BK
S807
G801
S563
S525
S805
G701
SEE GROUNDS

BEST COPY AVAILABLE

JOB SHEET 1

Inspect and replace a control head assembly.

STUDENT'S NAME ____________________ DATE ______________

EVALUATOR'S NAME __________________ ATTEMPT NO. _____

INSTRUCTIONS

When you are ready to perform this task, ask your instructor to observe the procedure and complete this form. All items listed under "Process Evaluation" must receive a "Yes" for you to receive an acceptable performance evaluation.

PROCESS EVALUATION

Evaluator Note: Place a check mark in the "Yes" or "No" blanks to designate whether or not the student has satisfactorily achieved each step in this procedure. If the student is unable to achieve this competency, have the student review the materials and try again.

The student	YES	NO
1. Performed a visual check.	_____	_____
2. Disconnected power source.	_____	_____
3. Located the control head assembly in dash.	_____	_____
4. Noted (if needed) the color code of each vacuum line and attachment pin and disconnected vacuum lines from control head.	_____	_____
5. Removed temperature door cable from control head by removing the clip and disconnecting the cable.	_____	_____
6. Disconnected any electrical wires, noting where they were attached so reattachment could be done correctly.	_____	_____
7. Removed screws connecting control head to dash if needed.	_____	_____
8. Lifted control head from dash.	_____	_____

		YES	NO
9.	Inserted new control head.	____	____
10.	Replaced screws connecting control head to dash if needed.	____	____
11.	Reconnected electrical wires to their appropriate points.	____	____
12.	Reconnected temperature door cable.	____	____
13.	Reconnected vacuum lines to their appropriate connection pin or reconnected common disk.	____	____
14.	Reported to instructor.	____	____
15.	Tested control head.	____	____
16.	Used proper tools correctly.	____	____
17.	Performed steps in a timely manner.	____	____
18.	Practiced safety rules throughout the procedure.	____	____
19.	Provided satisfactory responses to questions asked.	____	____
20.	Put away tools and equipment and cleaned work area.	____	____

EVALUATOR'S COMMENTS ____

____

PRODUCT EVALUATION

Evaluator Note: Rate the student on the following criteria by circling the appropriate numbers. Each criterion must receive a rating of "3" or higher to demonstrate student mastery. (See performance evaluation key.) A student who is unable to demonstrate mastery should review the materials and submit another product for evaluation.

Criteria				
Product meets manufacturer's installation specifications.	4	3	2	1
Product meets manufacturer's adjustment specifications.	4	3	2	1
Product includes proper components/materials.	4	3	2	1
Product meets performance requirements.	4	3	2	1

EVALUATOR'S COMMENTS

____

____

____

AVERAGE RATING

Evaluator Note: To obtain an average rating for the competency profile, total the designated points in "Product Evaluation" and divide by the total number of criteria. Circle the rating on the "Performance Evaluation Key" below.

PERFORMANCE EVALUATION KEY

4 — Skilled — Can perform job with no additional training.
3 — Moderately skilled — Has performed job during training program; limited additional training may be required.
2 — Limited skill — Has performed job during training program; additional training is required to develop skill.
1 — Unskilled — Is familiar with process, but is unable to perform job.

JOB SHEET 2

Use a vacuum tee and gauge to determine source of lost vacuum in vacuum lines.

STUDENT'S NAME ____________________ DATE ______________

EVALUATOR'S NAME ____________________ ATTEMPT NO. _____

INSTRUCTIONS

When you are ready to perform this task, ask your instructor to observe the procedure and complete this form. All items listed under "Process Evaluation" must receive a "Yes" for you to receive an acceptable performance evaluation.

PROCESS EVALUATION

Evaluator Note: Place a check mark in the "Yes" or "No" blanks to designate whether or not the student has satisfactorily achieved each step in this procedure. If the student is unable to achieve this competency, have the student review the materials and try again.

The student	YES	NO
1. Inserted vacuum tee in vacuum supply line before the vacuum reservoir.	_____	_____
2. Started car.	_____	_____
3. Had another person move the function control switch to all possible positions. ("A/C Max," "A/C Norm," "Vent," etc.)	_____	_____
4. Read the gauge at all positions of the function control switch.	_____	_____
5. Referred to the possible outcomes in order to know where vacuum is being lost.	_____	_____
6. Found the vacuum line which was losing vacuum.	_____	_____
7. Used proper tools correctly.	_____	_____
8. Performed steps in a timely manner.	_____	_____

		YES	NO
9.	Provided satisfactory answers to questions asked.	____	____
10.	Put away tools and equipment and cleaned the work area.	____	____

EVALUATOR'S COMMENTS

____

____

PRODUCT EVALUATION

Evaluator Note: Rate the student on the following criteria by circling the appropriate numbers. Each criterion must receive a rating of "3" or higher to demonstrate student mastery. (See performance evaluation key.) A student who is unable to demonstrate mastery should review the materials and submit another product for evaluation.

Criteria				
Product meets manufacturer's installation specifications.	4	3	2	1
Product meets manufacturer's adjustment specifications.	4	3	2	1
Product includes proper components/materials.	4	3	2	1
Product meets performance requirements.	4	3	2	1

EVALUATOR'S COMMENTS

AVERAGE RATING

Evaluator Note: To obtain an average rating for the competency profile, total the designated points in "Product Evaluation" and divide by the total number of criteria. Circle the rating on the "Performance Evaluation Key" below.

PERFORMANCE EVALUATION KEY

- 4 — Skilled — Can perform job with no additional training.
- 3 — Moderately skilled — Has performed job during training program; limited additional training may be required.
- 2 — Limited skill — Has performed job during training program; additional training is required to develop skill.
- 1 — Unskilled — Is familiar with process, but is unable to perform job.

PRACTICAL TEST 3

AIR CONDITIONING MECHANICAL AND ELECTRICAL CONTROLS

III

JOB SHEET 3

Replace vacuum lines.

STUDENT'S NAME ____________________ DATE ______________

EVALUATOR'S NAME ____________________ ATTEMPT NO. _____

INSTRUCTIONS

When you are ready to perform this task, ask your instructor to observe the procedure and complete this form. All items listed under "Process Evaluation" must receive a "Yes" for you to receive an acceptable performance evaluation.

PROCESS EVALUATION

Evaluator Note: Place a check mark in the "Yes" or "No" blanks to designate whether or not the student has satisfactorily achieved each step in this procedure. If the student is unable to achieve this competency, have the student review the materials and try again.

The student	YES	NO
1. Located the vacuum line which was the source of lost vacuum.	_____	_____
2. Checked the entire line for cracks or bad connections.	_____	_____
3. Removed the bad vacuum line.	_____	_____
4. Cut the new vacuum line about ½ inch longer than the section removed.	_____	_____
5. Replaced bad section.	_____	_____
6. Used proper tools correctly.	_____	_____
7. Performed steps in a timely manner.	_____	_____
8. Provided satisfactory responses to questions asked.	_____	_____
9. Put away tools and equipment and cleaned the work area.	_____	_____

EVALUATOR'S COMMENTS

PRODUCT EVALUATION

Evaluator Note: Rate the student on the following criteria by circling the appropriate numbers. Each criterion must receive a rating of "3" or higher to demonstrate student mastery. (See performance evaluation key.) A student who is unable to demonstrate mastery should review the materials and submit another product for evaluation.

Criteria				
Product meets manufacturer's installation specifications.	4	3	2	1
Product meets manufacturer's adjustment specifications.	4	3	2	1
Product includes proper components materials.	4	3	2	1
Product meets performance requirements.	4	3	2	1

EVALUATOR'S COMMENTS

____

____

____

AVERAGE RATING

Evaluator Note: To obtain an average rating for the competency profile, total the designated points in "Product Evaluation" and divide by the total number of criteria. Circle the rating on the "Performance Evaluation Key" below.

PERFORMANCE EVALUATION KEY

4 — Skilled — Can perform job with no additional training.

3 — Moderately skilled — Has performed job during training program; limited additional training may be required.

2 — Limited skill — Has performed job during training program; additional training is required to develop skill.

1 — Unskilled — Is familiar with process, but is unable to perform job.

PRACTICAL TEST 4

AIR CONDITIONING MECHANICAL AND ELECTRICAL CONTROLS III

JOB SHEET 4

Inspect and replace electrical controls.

STUDENT'S NAME ______________________ DATE ______________

EVALUATOR'S NAME ____________________ ATTEMPT NO. ______

INSTRUCTIONS

When you are ready to perform this task, ask your instructor to observe the procedure and complete this form. All items listed under "Process Evaluation" must receive a "Yes" for you to receive an acceptable performance evaluation.

PROCESS EVALUATION

Evaluator Note: Place a check mark in the "Yes" or "No" blanks to designate whether or not the student has satisfactorily achieved each step in this procedure. If the student is unable to achieve this competency, have the student review the materials and try again.

The student	YES	NO
Procedure 1: Inspected electrical controls.		
1. Located the electrical control.	_____	_____
2. Checked wires for split casing.	_____	_____
3. Checked wire attachments to the electrical control for solid connections.	_____	_____
4. Attached VOM to electrical control.	_____	_____
5. Compared reading on VOM to owner's manual specification.	_____	_____
6. Reported bad wires or connections to instructor.	_____	_____
7. Used proper tools correctly.	_____	_____
8. Performed steps in a timely manner.	_____	_____
9. Practiced safety rules throughout procedure.	_____	_____

	YES	NO
10. Provided satisfactory responses to questions asked.	____	____
11. Put away tools and equipment and cleaned work area.	____	____

Procedure 2: Replaced electrical controls.

1. Disconnected the power source.	____	____
2. Noted the position of electrical plug.	____	____
3. Disconnected plug from the electrical control.	____	____
4. Removed the electrical control from its mounting hardware.	____	____
5. Placed the new electrical control in mounting hardware.	____	____
6. Reconnected electrical plug.	____	____
7. Reconnected the power source.	____	____
8. Used proper tools correctly.	____	____
9. Practiced safety rules throughout procedure.	____	____
10. Provided satisfactory responses to questions asked.	____	____
11. Put away tools and equipment and cleaned work area.	____	____

EVALUATOR'S COMMENTS ____

____

PRODUCT EVALUATION

Evaluator Note: Rate the student on the following criteria by circling the appropriate numbers. Each criterion must receive a rating of "3" or higher to demonstrate student mastery. (See performance evaluation key.) A student who is unable to demonstrate mastery should review the materials and submit another product for evaluation.

Criteria				
Product meets manufacturer's installation specifications.	4	3	2	1
Product meets manufacturer's adjustment specifications.	4	3	2	1
Product includes proper components/materials.	4	3	2	1
Product meets performance requirements.	4	3	2	1
Product appearance meets industry standards.	4	3	2	1

EVALUATOR'S COMMENTS

____

____

____

AVERAGE RATING

Evaluator Note: To obtain an average rating for the competency profile, total the designated points in "Product Evaluation" and divide by the total number of criteria. Circle the rating on the "Performance Evaluation Key" below.

PERFORMANCE EVALUATION KEY

4 — Skilled — Can perform job with no additional training.
3 — Moderately skilled — Has performed job during training program; limited additional training may be required.
2 — Limited skill — Has performed job during training program; additional training is required to develop skill.
1 — Unskilled — Is familiar with process, but is unable to perform job.

PRACTICAL TEST 5

AIR CONDITIONING MECHANICAL AND ELECTRICAL CONTROLS

JOB SHEET 5

Inspect and replace idle controls.

STUDENT'S NAME ____________________ DATE ______________

EVALUATOR'S NAME _________________ ATTEMPT NO. ______

INSTRUCTIONS

When you are ready to perform this task, ask your instructor to observe the procedure and complete this form. All items listed under "Process Evaluation" must receive a "Yes" for you to receive an acceptable performance evaluation.

PROCESS EVALUATION

Evaluator Note: Place a check mark in the "Yes" or "No" blanks to designate whether or not the student has satisfactorily achieved each step in this procedure. If the student is unable to achieve this competency, have the student review the materials and try again.

The student	YES	NO
Procedure 1: Inspected idle controls.		
1. Located the idle solenoid on the carburetor.	_____	_____
2. Checked wires for split casing.	_____	_____
3. Checked wire attachments to the solenoid for solid connections.	_____	_____
4. Attached VOM to solenoid.	_____	_____
5. Compared reading on VOM to owner's manual specification.	_____	_____
6. Reported bad wires or connections to instructor.	_____	_____
7. Used proper tools correctly.	_____	_____
8. Performed steps in a timely manner.	_____	_____
9. Practiced safety rules throughout procedure.	_____	_____

	YES	NO
10. Provided satisfactory responses to questions asked.	_____	_____
11. Put away tools and equipment and cleaned work area.	_____	_____
Procedure 2: Replaced idle controls.		
1. Disconnected the power source.	_____	_____
2. Noted the plug connector position.	_____	_____
3. Disconnected plug from the solenoid.	_____	_____
4. Removed the solenoid from the carburetor.	_____	_____
5. Attached new solenoid on carburetor.	_____	_____
6. Reconnected plug.	_____	_____
7. Reconnected the power source.	_____	_____
8. Started the engine.	_____	_____
9. Turned on the air conditioning.	_____	_____
10. Adjusted the idle speed of the engine to the owner's manual specification.	_____	_____
11. Used proper tools correctly.	_____	_____
12. Performed steps in a timely manner.	_____	_____
13. Practiced safety rules throughout procedure.	_____	_____
14. Provided satisfactory responses to questions asked.	_____	_____
15. Put away tools and equipment and cleaned work area.	_____	_____

EVALUATOR'S COMMENTS

PRODUCT EVALUATION

Evaluator Note: Rate the student on the following criteria by circling the appropriate numbers. Each criterion must receive a rating of "3" or higher to demonstrate student mastery. (See performance evaluation key.) A student who is unable to demonstrate mastery should review the materials and submit another product for evaluation.

Criteria				
Product meets manufacturer's installation specifications.	4	3	2	1
Product meets manufacturer's adjustment specifications.	4	3	2	1
Product includes proper components/materials.	4	3	2	1
Product meets performance requirements.	4	3	2	1
Product appearance meets industry standards.	4	3	2	1

EVALUATOR'S COMMENTS

AVERAGE RATING

Evaluator Note: To obtain an average rating for the competency profile, total the designated points in "Product Evaluation" and divide by the total number of criteria. Circle the rating on the "Performance Evaluation Key" below.

PERFORMANCE EVALUATION KEY

4 — Skilled — Can perform job with no additional training.
3 — Moderately skilled — Has performed job during training program; limited additional training may be required.
2 — Limited skill — Has performed job during training program; additional training is required to develop skill.
1 — Unskilled — Is familiar with process, but is unable to perform job.

PRACTICAL TEST 6	**AIR CONDITIONING MECHANICAL AND ELECTRICAL CONTROLS** **III**

JOB SHEET 6

Inspect and replace idle speed controls.

STUDENT'S NAME ______________ DATE ____________

EVALUATOR'S NAME ______________ ATTEMPT NO. _____

INSTRUCTIONS

When you are ready to perform this task, ask your instructor to observe the procedure and complete this form. All items listed under "Process Evaluation" must receive a "Yes" for you to receive an acceptable performance evaluation.

PROCESS EVALUATION

Evaluator Note: Place a check mark in the "Yes" or "No" blanks to designate whether or not the student has satisfactorily achieved each step in this procedure. If the student is unable to achieve this competency, have the student review the materials and try again.

The student	YES	NO
1. Referred to vehicle manufacturer's manual for proper procedures.	_____	_____
2. Used proper tools correctly.	_____	_____
3. Practiced safety rules throughout procedure.	_____	_____
4. Provided satisfactory responses to questions asked.	_____	_____
5. Put away tools and equipment and cleaned work area.	_____	_____

EVALUATOR'S COMMENTS

____

____

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PRODUCT EVALUATION

Evaluator Note: Rate the student on the following criteria by circling the appropriate numbers. Each criterion must receive a rating of "3" or higher to demonstrate student mastery. (See performance evaluation key.) A student who is unable to demonstrate mastery should review the materials and submit another product for evaluation.

Criteria				
Product meets manufacturer's installation specifications.	4	3	2	1
Product meets manufacturer's adjustment specifications.	4	3	2	1
Product includes proper components/materials.	4	3	2	1
Product meets performance requirements.	4	3	2	1
Product appearance meets industry standards.	4	3	2	1

EVALUATOR'S COMMENTS

AVERAGE RATING

Evaluator Note: To obtain an average rating for the competency profile, total the designated points in "Product Evaluation" and divide by the total number of criteria. Circle the rating on the "Performance Evaluation Key" below.

PERFORMANCE EVALUATION KEY

4 — Skilled — Can perform job with no additional training.
3 — Moderately skilled — Has performed job during training program; limited additional training may be required.
2 — Limited skill — Has performed job during training program; additional training is required to develop skill.
1 — Unskilled — Is familiar with process, but is unable to perform job.

NAME ______________________________ SCORE ______

OBJECTIVE 1

Match terms associated with air conditioning mechanical and electrical controls to their definitions. Write the correct letter in each blank.

______1. To take air from inside the car, heat or cool it, and move it into the car

______2. To provide air

______3. Evens out fluctuations in vacuum pressure when engine speed increases and decreases

______4. Prevents loss of vacuum to the vacuum reservoir during acceleration

a. Vacuum reservoir

b. Recirculation

c. Float

d. Air conditioning

e. Recycling

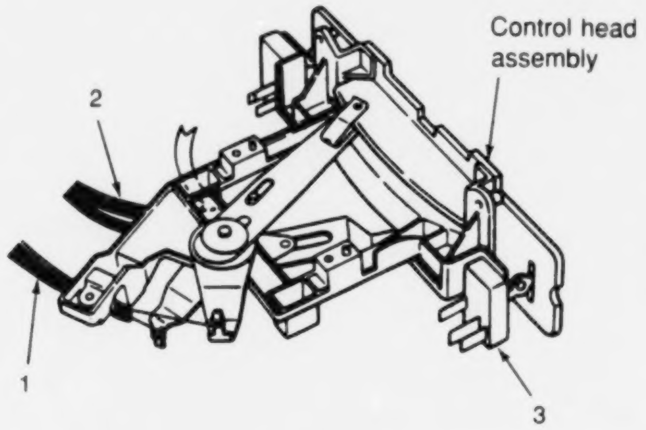
f. Ventilation

g. Check valve

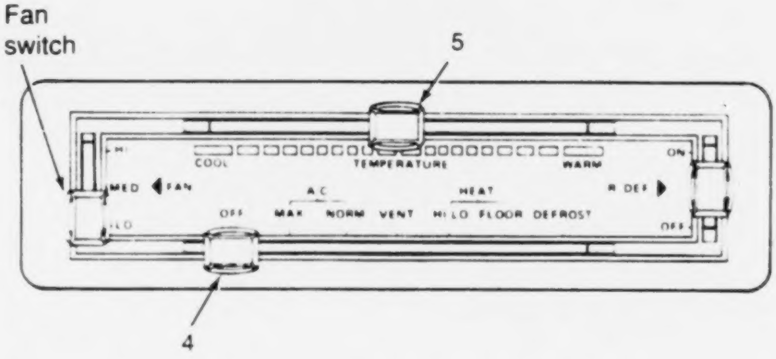
OBJECTIVE 2

Label the parts of the air conditioning mechanical controls. For items *a* through *e* below, refer to the illustration below, and write the correct part name in each blank.

- Vacuum cables
- Temperature control switch
- Fan speed switch
- Vacuum lines
- Temperature control cable
- Function control switch


Control head assembly
2
1
3

Back


Fan switch
5
HI
COOL
TEMPERATURE
WARM
ON
MED
FAN
A/C
HEAT
R DEF
OFF
MAX
NORM
VENT
HI-LO
FLOOR
DEFROST
LO
OFF
4

Front

1. ______________________

2. ______________________

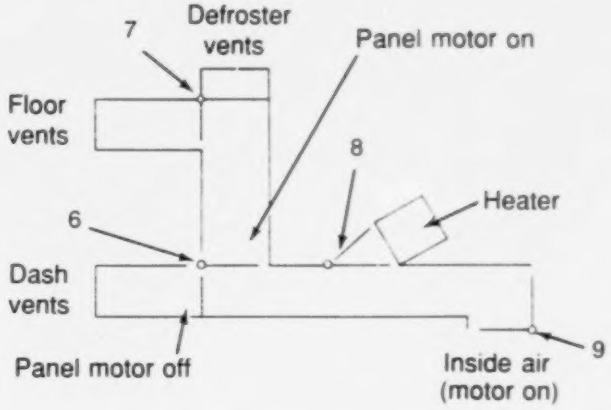
3. ______________________

4. ______________________

5. ______________________

NOTE: For items *6* through *9* below, refer to the illustration below, and write the correct part name in each blank.

- Recirculation
- Heater control
- Defroster/floor
- Temperature control
- Panel



7
Defroster vents
Panel motor on
Floor vents
8
Heater
6
Dash vents
Panel motor off
Inside air (motor on)
9

Airflow doors

6. ____________________

7. ____________________

8. ____________________

9. ____________________

OBJECTIVE 3 **State the functions of the control head assembly switches.**

1. **Fan speed switch** — ________________________________

____

2. **Function control switch** — ____________________________

____

3. **Temperature control switch** — __________________________

____

OBJECTIVE 4 **Match airflow doors to their functions.** For questions 1 through 4 below, write the correct letter in each blank.

______1. An opening that directs airflow to the defroster/floor airflow door or to the dash vents.

______2. An opening that directs airflow to the defroster vents or floor vents.

______3. An opening that closes in order to keep outside air from entering the car and opens to allow outside air into the car.

______4. An opening that allows warm air from the heater to mix with air flowing through the ventilation system.

a. Cooled air

b. Defroster/floor

c. Heated air

d. Panel

e. Recirculation

f. Temperature control

OBJECTIVE 5 **Select from a list true statements about a vacuum motor.** Write an "X" before each true statement.

______1. A vacuum motor allows the operator to open airflow doors from the passenger's or driver's seat of the car.

______2. The vacuum motor allows the operator to control the airflow in the car by moving the function control switch.

______3. The recirculation airflow door does not have a vacuum motor attached to it.

______4. The defroster/floor airflow door has a vacuum motor attached to it.

______5. The panel airflow door does not have a vacuum motor attached to it.

______6. The temperature control airflow door has a vacuum motor attached to it.

______7. The function control switch opens a connection between vacuum lines from the vacuum motor to the engine manifold.

______8. The engine manifold pulls on the vacuum motor, which opens the airflow door.

OBJECTIVE 6

Identify the vacuum motor working at each position of the function control switch. Write an "X" in the column if that motor is on.

Function control switch	Recirculation	Panel	Defroster/ floor
1. Off	______	______	______
2. A/C Max	______	______	______
3. A/C Norm	______	______	______
4. Vent	______	______	______

OBJECTIVE 7

Identify the electrical controls operating at each position of the function control switch. Write an "X" in the column if the electrical control is on.

Function control switch	Air compressor	Fan speed switch
1. Off	______	______
2. A/C Max	______	______
3. A/C Norm	______	______
4. Vent	______	______

NOTICE	The following assignment sheets and job sheets are not part of the written test. If they have not been completed, check with your instructor.	
OBJECTIVE 8	**Diagnose problems in the vacuum lines.**	SCORE ______
OBJECTIVE 9	**Interpret a wiring diagram.**	SCORE ______
OBJECTIVE 10	**Diagnose electrical problems.**	SCORE ______
OBJECTIVE 11a	**Inspect and replace a control head assembly.**	RATING ______
OBJECTIVE 11b	**Use a vacuum tee and gauge to determine source of lost vacuum in vacuum lines.**	RATING ______
OBJECTIVE 11c	**Replace vacuum lines.**	RATING ______
OBJECTIVE 11d	**Inspect and replace electrical controls.**	RATING ______
OBJECTIVE 11e	**Inspect and replace idle controls.**	RATING ______
OBJECTIVE 11f	**Inspect and replace idle speed controls.**	RATING ______

WRITTEN TEST ANSWERS

AIR CONDITIONING MECHANICAL AND ELECTRICAL CONTROLS III

OBJECTIVE 1

1. b
2. f
3. a
4. g

OBJECTIVE 2

Control head assembly

1. Temperature control cable
2. Vacuum lines
3. Fan speed switch
4. Function control switch
5. Temperature control switch

Airflow doors

6. Defroster/floor
7. Panel
8. Temperature control
9. Recirculation

OBJECTIVE 3

1. **Fan speed switch** — An electrical switch that causes the ventilation system fan to increase or decrease.
2. **Function control switch** — A lever that operates different airflow doors and electrical devices in order to allow the operator to control the ventilation system.
3. **Temperature control switch** — A lever connected by cable to the temperature control airflow door that allows the operator to change the temperature of the air.

OBJECTIVE 4

1. d
2. b
3. e
4. f

OBJECTIVE 5

1, 2, 4, 7, 8

OBJECTIVE 6

Function control switch	Recirculation	Panel	Defroster/floor
1. Off	X		X
2. A/C Max	X	X	X
3. A/C Norm		X	X
4. Vent		X	X

OBJECTIVE 7

Function control switch	Air compressor	Fan speed switch
1. Off		
2. A/C Max	X	X
3. A/C Norm	X	X
4. Vent		

OBJECTIVE 8 Refer to answers to Assignment Sheet 1.

OBJECTIVE 9 Refer to answers to Assignment Sheet 2.

OBJECTIVE 10 Refer to answers to Assignment Sheet 3.

OBJECTIVE 11 Refer to Practical Test ratings for Job Sheets 1-6.

OBJECTIVE SHEET

HEATING MECHANICAL AND ELECTRICAL CONTROLS *IV*

INTRODUCTION

The driver or passengers of automobiles may wish to change the temperature of air in the car. Often this means getting heated air into the passenger compartment of the car. Persons in the car must be able to control the amount of warm air entering the car in order to provide optimal comfort. This is accomplished using heated coolant from the engine block and airflow doors in the dash. The driver or passenger can control these devices using heating controls located on the dash.

UNIT OBJECTIVE

After completing this unit, the student should be able to identify components of heater controls. The student should be able to inspect and replace components of these controls. The student will demonstrate these competencies by completing the assignment sheets and the written test with a minimum of 85 percent accuracy.

PREREQUISITE

The student must have successfully completed the core curriculum. *Introduction to Automotive Service, Electrical Systems Specialist,* Units I-III.

SPECIFIC OBJECTIVES

After completing this unit, the student should be able to

1. Name the vacuum motor working at each position of the function control switch.
2. Diagnose problems in the vacuum lines. (Assignment sheet 1)
3. Diagnose electrical problems. (Assignment Sheet 2)

SUGGESTED ACTIVITIES — HEATING MECHANICAL AND ELECTRICAL CONTROLS — IV

PREPARATION

- Review unit and plan presentation.
- Give Pretest.
- Determine scope and sequence of objectives that you add. Design and develop support materials, including evaluation techniques, for additional objectives.
- Review teaching suggestions and plan classroom activities.
- Determine how you will schedule time for students to demonstrate competence in the required procedures.
- Order materials to supplement unit.
- Invite a local auto mechanic to the class to discuss heating systems.

  NOTE: Supply guest speakers with the Objective Sheet, Information Sheet, and any other components you want them to cover.

DELIVERY

Objective 1 Name the vacuum motor working at each position of the function control switch.

- Stress the similarity between heater and defroster.
- Point out that the heater core is always working. Hot air flows out only when the temperature control door allows warm air to enter the ventilation system.

APPLICATION

Objective 2 Diagnose problems in the vacuum lines. (Assignment Sheet 1)

Objective 3 Diagnose electrical problems. (Assignment Sheet 2)

- Use Assignment Sheets 1 and 2 to help students learn to diagnose mechanical and electrical problems.

EVALUATION

Pretest

- Pretest qualifying students.

- Determine individual requirements from pretest results.
- Counsel students individually on pretest results and study requirements.

Written Test

- Explain to students that they will be asked to demonstrate on the written test actions listed in the specific objectives.
- Give written test.
- Evaluate students on assignment sheet activities if not previously done.
- Reteach and retest if necessary.
- Complete appropriate section of competency profiles.
- Review individual and group performance in order to evaluate teaching methods. Adjust scope, sequence, or instructional approaches for additional lessons as required.

SUGGESTED RESOURCES

Publications

- *Auto Mechanics*, by Jay Webster, Glencoe/McGraw-Hill, 2nd edition. Covers automobile air conditioning and heating for entry-level vocational training. Activity Guide and Instructor's Manual and Key available. Call 1-800-423-9534.
- *Automotive Air Conditioning and Heating*, by Ivan Hinerman and Tom Birch. Provides in-depth text and procedures for troubleshooting and service. Glencoe, Mission Hills, California. Call 1-800-257-5755.
- *Fundamentals of Air Conditioning*, General Motors course materials; instructor and student manuals. Includes operation, diagnosis, purging, leak and performance testing; 67 overhead transparencies. Call 1-800-468-6657.
- *Air Conditioning*, Chrysler Motors Service Publication on principles, operation, components, function, diagnoses and controls for Chryslers through 1988. Student Reference Book order No. 81-699-8031. Audiotape and videotape support available. Write to Chrysler Motors Service Training, 26001 Lawrence Avenue, Center Line, Michigan 48015.

Audiovisual materials

Media

- *Air Conditioning Compressor Seal Service.* OL, MI-8011V-TTS. Available from Career Aids Division, 20417 Nordhoff St., Dept. R 4 5, Chatsworth, CA 91311.
- *Air Conditioning Diagnosis.* OL, MI-8009V-TTS. Available from Career Aids Division, 20417 Nordhoff St., Dept. R 4 5, Chatsworth, CA 91311.
- *Air Conditioning Performance Testing.* Chrysler Corporation, M-8671. Available from ASA, P.O. Box 1047, Bedford, TX 76095.
- *Air Conditioning System.* Ford Parts and Service Division, M-8001. Available from ASA, P.O. Box 1047, Bedford, TX 76095.
- *Automotive Air Conditioning Explained.* B-442X. Available from Teaching Aids, Inc., P.O. Box 1798, Costa Mesa, CA 92628.
- *Automotive Air Conditioning Service.* OL, MI-8008V-TTS. Available from Career Aids Division, 20417, Nordhoff St., Dept R 4 5, Chatsworth, CA 91311.
- *The Automotive Air Conditioner.* Set of 3 VHS cassettes. VHS 1, *Basic Parts and Principles* (17:52 min) addresses principles of air conditioning and identifies components and their functions. Demonstrates flow of freon through the system. VHS 2, *Using the Equipment*, (18:00 min) covers major equipment and tools used in air conditioning maintenance and repair; shows procedures for checking pressure, using freon, finding freon leaks. VHS 3, *Troubleshooting Problems*, (14:02 min) shows students how to detect freon leaks, how to troubleshoot, and how to correct problems. Videotapes can be purchased separately. Available from Bergwall Video Productions, Inc., 1-800-645-3565.
- *The Automotive Cooling System.* 406X-V11. Available from Bergwall Video Productions, Inc., P.O. Box 238, Garden City, NY 11530.

- *Basic Air Conditioning Systems.* OL. MI-8010V-TTS. Available from Career Aids Division, 20417 Nordhoff St., Dept. R 4 5, Chatsworth, CA 91311.
- *Discharge and Evaluation.* R-AB138. Available from Teaching Aids, Inc., P.O. Box 1798, Costa Mesa, CA 92628.
- *Draining the Cooling System.* OL, 010-486-TTS. Available from Career Aids Division, 20417 Nordhoff St., Dept. R 4 5, Chatsworth, CA 91311.
- *Heating and Air Conditioning.* Ford Parts and Service Division M-8669. Available from ASA, P.O. Box 1047, Bedford, TX 76095.
- *Keep Your Car Cool.* MO-706. Available from Teaching Aids, Inc., P.O. Box 1798, Costa Mesa, CA 92628.
- *Principles of Climate Control Air Distribution (Car and Light Truck).* ½" VHS, color, (45.56 min). Covers basics of refrigeration and heat transfer. Shows components and discusses functions; covers electrical system as related to heat and air conditioning. Order No: 3640-006A. Available from Ford Service Publications, P.O. Box 07150, Detroit, MI 48207. To place credit card orders, call 1-800-782-4356.
- *Recharge System.* R-AB139. Available from Teaching Aids, Inc., P.O. Box 1798, Costa Mesa, CA 92628.
- *Refilling the Cooling System.* OL, 010-486-TTS. Available from Career Aids Division, 20417 Nordhoff St., Dept R 4 5, Chatsworth, CA 91311.

UNIT REFERENCES

- Crouse, William H. and Anglin, Donald L. *Automotive Mechanics.* New York, McGraw-Hill Book Company, 1981.
- Mitchell Information Services, Inc., *Mitchell Automechanics.* New Jersey, Prentice Hall, 1982.
- *Automotive Air Conditioning and Heating* 0-02-818620-6 Glencoe Publishing Company, 1-800-257-5775.
- *Automotive Air Conditioning* 014857-0, McGraw-Hill Publishing Company, 1-800-334-7344.

PRETEST ANSWERS

HEATING MECHANICAL AND ELECTRICAL CONTROLS IV

EVALUATOR NOTE

Use the following answer key to check student answers to pretest questions. To determine the student's individual study requirements from pretest results, use the following table, which shows the correlation between the objectives and pretest questions. Counsel the students individually on pretest results and study requirements.

TABLE

Correlation between objective and pretest questions

Objective	Question(s)
1	1, 2, 3
2	4
3	5

ANSWER KEY

1. b
2. a
3. b
4. b
5. b

PRETEST

HEATING MECHANICAL AND ELECTRICAL CONTROLS

NAME ______________________ SCORE ______

DIRECTIONS

Read the following questions and problems. Select the item that best answers the question or problem, and write the correct letter in each blank.

OBJECTIVE 1

______1. When the function control switch is set to "OFF," the ___.

a. defroster/floor vacuum motor is off
b. defroster/floor vacuum motor is on
c. recirculation vacuum motor is off

______2. When the function control switch is set to "HEATER," ___.

a. recirculation vacuum motor is on
b. panel vacuum motor is on
c. defroster/floor vacuum motor is off

______3. When the function control switch is set to "DEFROST," ___.

a. recirculation vacuum motor is off
b. defroster/floor vacuum motor is off
c. panel vacuum motor is on

OBJECTIVE 2

______4. A customer's car has a temperature control switch that is stuck in the "HOT" position. The most likely cause is a ___.

a. leak in the vacuum line to the temperature control airflow door
b. problem with the cable to the temperature control airflow door
c. bad vacuum reservoir

OBJECTIVE 3

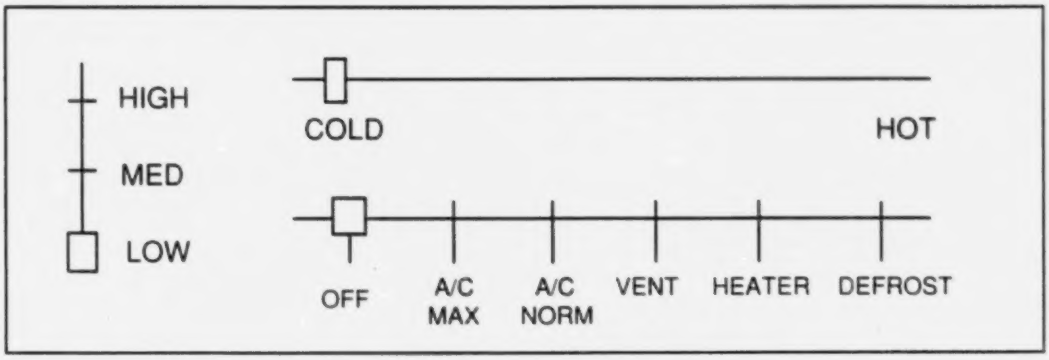
______5. When working on the heater of a customer's car, you find that the fan will not turn on at any position of the fan speed switch. The problem is a short in the ___.

a. heater core electrical circuit
b. fan electrical circuit
c. fan resistors

INFORMATION SHEET

HEATING MECHANICAL AND ELECTRICAL CONTROLS IV

OBJECTIVE 1 **Name the vacuum motor working at each position of the function control switch.**


HIGH
MED
LOW
COLD
HOT
OFF
A/C MAX
A/C NORM
VENT
HEATER
DEFROST

Control Panel

Function Control Switch	Recirculation	Panel	Floor/defroster
1. Off	X		X
2. Heater	X		X
3. Floor/ defroster	X		X

NOTE: An "X" means the vacuum motor is on.

ASSIGNMENT SHEET 1

HEATING MECHANICAL AND ELECTRICAL CONTROLS IV

NAME ______________________________ SCORE ________

OBJECTIVE 2 **Diagnose problems in the vacuum lines.**

INTRODUCTION

Although the location of the control head, airflow doors, and vacuum lines may differ between cars, all cars will have a similar system. A lack of airflow out the panel vents will almost always be associated with the panel airflow door, its vacuum motor, or the vacuum line to the vacuum motor.

DIRECTIONS

Each of the statements below describes a problem in the heating/defroster system. Read the statement carefully. Write the correct letter in each blank.

______1. A customer's car has a temperature control switch that is stuck in the cold position. The most likely cause is a ___.

a. leak in the vacuum line to the temperature control airflow door
b. problem with the cable to the temperature control airflow door
c. bad vacuum reservoir

______2. Upon inspecting a customer's vacuum lines, you find one that is cracked. You should ___.

a. use a tee and gauge in order to check the pressure
b. replace the entire vacuum line
c. replace the cracked portion with a plastic tube

______3. You are test driving a customer's car. You notice that at any position of the function control switch, no air flows from the floor vents. The problem most likely is in the ___.

a. vacuum line to the floor/defrost airflow door
b. vacuum line to the heater function control switch
c. cable to the floor airflow door

______4. You are using a tee and gauge to check for leaks in a car's vacuum lines. You have inserted the tee and gauge before the vacuum reservoir. The gauge reads below normal at some positions of the function control switch. You now know that ___.

a. vacuum is being lost in the lines active at the positions which are below normal
b. vacuum is being lost in the supply line
c. you must use the tee and gauge at the vacuum reservoir

______5. You are still working on the car described in #4. Now, however, the gauge reads normal at all positions of the function control switch. You now know that ___.

a. vacuum is being lost in the lines
b. vacuum is being lost in the supply line
c. you must use the tee and gauge at the vacuum reservoir

ASSIGNMENT SHEET 2

HEATING MECHANICAL AND ELECTRICAL CONTROLS IV

NAME ______________________________ SCORE ________

OBJECTIVE 3 **Diagnose electrical problems.**

INTRODUCTION Electrical problems can be difficult to locate but easy to repair. The art of finding an electrical problem is in finding the circuit that is bad. The circuit can be found only by testing the parts connected to it.

DIRECTIONS For each of the situations below, choose the best answer. Then write the correct letter in each blank.

______1. You are working on a customer's car. You find that the fan will not work at any speed. The problem is ___.

a. a fuse is blown
b. in the fan speed electrical circuit
c. in a resistor

______2. Mr. Drexter brings his car to you. You notice that the fan works on the car, but it does not change speeds. The problem is in the ___.

a. fan fuse
b. fan wires
c. resistors

______3. When running the heater of a customer's car, you find that the fan will not work. The problem is a short in the ___.

a. fan electrical circuit
b. heater core electrical circuit
c. fan resistors

ASSIGNMENT ANSWERS

HEATING MECHANICAL AND ELECTRICAL CONTROLS

IV

ASSIGNMENT SHEET 1

1. b
2. c
3. a
4. a
5. a

ASSIGNMENT SHEET 2

1. a
2. b
3. a

WRITTEN TEST

HEATING MECHANICAL AND ELECTRICAL CONTROLS

IV

NAME ______________________________ SCORE ______

OBJECTIVE 1 **Name the vacuum motor working at each position of the function control switch.** Write an "X" in the column if that motor is on.

Function Control Switch	Recirculation	Panel	Floor/defroster
1. Off			
2. Heater			
3. Floor/ defroster			

NOTICE The following assignment sheets are not part of the written test. If they have not been completed, check with your instructor.

OBJECTIVE 2 **Diagnose problems in the vacuum lines.** SCORE ______

OBJECTIVE 3 **Diagnose electrical problems.** SCORE ______

WRITTEN TEST ANSWERS

HEATING MECHANICAL AND ELECTRICAL CONTROLS IV

OBJECTIVE 1

Function Control Switch	Recirculation	Panel	Floor/defroster
1. Off	X		X
2. Heater	X		X
3. Floor/defroster	X		X

OBJECTIVE 2 Refer to answers to Assignment Sheet 1.

OBJECTIVE 3 Refer to answers to Assignment Sheet 2.

OBJECTIVE SHEET

HEATING

V

INTRODUCTION

The heating system is vital for passenger comfort in the winter. It runs continuously when the engine is on, and the heat produced by it is either allowed into the car or kept out of it. Since it is always running, problems can occur even in the summer months. A skilled technician must be able to identify the causes of heating system problems and fix them properly.

UNIT OBJECTIVE

After completing this unit, the student should be able to identify the major components of the heating system, have a working knowledge of how the components operate, and be able to fix any problems with the components. The student will demonstrate these competencies by completing assignment sheets, job sheets, practical tests, and the written test with a minimum of 85 percent accuracy.

PREREQUISITE

The student must have successfully completed the core curriculum, *Introduction to Automotive Service, Electrical Systems Specialist,* Units I-IV.

SPECIFIC OBJECTIVES

After completing this unit, the student should be able to

1. Define terms associated with heating.
2. Label the components of the heating system.
3. Match heating components to their functions.
4. Label the parts of a water pump.
5. Arrange in order the steps by which the heating system produces hot air.
6. Match common heating problems to their causes.
7. Analyze noise and performance. (Assignment Sheet 1)
8. Diagnose problems. (Assignment Sheet 2)
9. Diagnose cooling-system problems. (Assignment Sheet 3)

10. Demonstrate the ability to:
    a. Flush core. (Job Sheet 1)
    b. Remove and replace radiator. (Job Sheet 2)
    c. Remove and replace water pump. (Job Sheet 3)

PREPARATION

- Review unit and plan presentation.
- Give Pretest.
- Determine scope and sequence of objectives that you add. Design and develop support materials, including evaluation techniques, for additional objectives.
- Review teaching suggestions and plan classroom activities.
- Determine how you will schedule time for students to demonstrate competence in the required procedures.
- Order materials to supplement unit.
- Invite a local auto mechanic to speak to the class.

NOTE: Supply guest speakers with the Objective Sheet, Information Sheet, and any other components you want them to cover.

DELIVERY

Objective 1 Define terms associated with heating.

- Review terms and definitions for the class.
- Point out that coolant flows through the radiator.

Objective 2 Label the components of the heating system.

- Explain to the students that the engine cooling and heating systems are interrelated.

Objective 3 Match heating components to their functions.

- Explain to the students that although the radiator is cooling engine coolant, the coolant is still relatively hot.
- Stress that the heater core is always producing heat.

Objective 4 Label the parts of a water pump.

- Show the students how the pump wheel forces coolant into the pump at one end and out it at the other.

- Note that the pump is always working when the engine is on.

Objective 5 Arrange in order the steps by which the heating system produces hot air.

- Show the students that engine coolant is cooled by both the radiator and the heater core.
- Explain to the students that warm air is allowed to enter the car through the temperature control door.

Objective 6 Match common heating problems to their causes.

- Help the students see the link between causes of heating problems and their effects.
- Note that many heating problems are also engine-coolant system problems.

APPLICATION

Objective 7 Analyze noise and performance.

- Use Assignment Sheet 1 to help the students analyze noise and performance.

Objective 8 Diagnose problems.

- Use Assignment Sheet 2 to help the students diagnose problems.

Objective 9 Diagnose cooling-system problems.

- Use Assignment Sheet 3 to help the students diagnose cooling-system problems.

Objective 10 Demonstrate the ability to:

- Flush core. (Job Sheet 1)
- Remove and replace radiator. (Job Sheet 2)
- Remove and replace water pump. (Job Sheet 3)
- Use Job Sheets 1 - 3 to help the students perform basic heating-system maintenance.

EVALUATION

Pretest

- Pretest qualifying students.
- Determine individual requirements from pretest results.
- Counsel students individually on pretest results and study requirements.

Practical Test

- Explain to students that they will be asked to demonstrate procedures on the job sheets to complete the practical tests.
- Describe the rating scale used on the practical tests.
- Reteach and retest as necessary.

Written Test

- Explain to students that they will be asked to demonstrate on the written test actions listed in the specific objectives.
- Give written test.

  NOTE: The written test may be given in sections if desired.

- Evaluate students on assignment sheet activities if not previously done.
- Reteach and retest if necessary.
- Complete appropriate section of competency profiles.
- Review individual and group performance in order to evaluate teaching methods. Adjust scope, sequence, or instructional approaches for additional lessons as required.

SUGGESTED RESOURCES

Media

- *Air Conditioning Compressor Seal Service*. OL, MI-8011V-TTS. Available from Career Aids Division, 20417 Nordhoff St., Dept. R 4 5, Chatsworth, CA 91311.

- *Air Conditioning Diagnosis.* OL. MI-8009V-TTS. Available from Career Aids Division, 20417 Nordhoff St., Dept. R 4 5, Chatsworth, CA 91311.

- *Air Conditioning Performance Testing.* Chrysler Corporation, M-8671. Available from ASA, P.O. Box 1047, Bedford, TX 76095.

- *Air Conditioning System.* Ford Parts and Service Division, M-8001. Available from ASA, P.O. Box 1047, Bedford, TX 76095.

- *Automotive Air Conditioning Explained.* B-442X. Available from Teaching Aids, Inc., P.O. Box 1798, Costa Mesa, CA 92628.

- *Automotive Air Conditioning Service.* OL. MI-8008V-TTS. Available from Career Aids Division, 20417, Nordhoff St., Dept R 4 5, Chatsworth, CA 91311.

- *The Automotive Air Conditioner.* Set of 3 VHS cassettes. VHS 1, *Basic Parts and Principles* (17:52 min) addresses principles of air conditioning and identifies components and their functions. Demonstrates flow of freon through the system. VHS 2, *Using the Equipment*, (18:00 min) covers major equipment and tools used in air conditioning maintenance and repair; shows procedures for checking pressure, using freon, finding freon leaks. VHS 3, *Troubleshooting Problems*, (14:02 min) shows students how to detect freon leaks, how to troubleshoot, and how to correct problems. Videotapes can be purchased separately. Available from Bergwall Video Productions, Inc., 1-800-645-3565.

- *The Automotive Cooling System.* 406X-V11. Available from Bergwall Video Productions, Inc., P.O. Box 238, Garden City, NY 11530.

- *Basic Air Conditioning Systems.* OL, MI-8010V-TTS. Available from Career Aids Division, 20417 Nordhoff St., Dept. R 4 5, Chatsworth, CA 91311.

- *Discharge and Evaluation.* R-AB138. Available from Teaching Aids, Inc., P.O. Box 1798, Costa Mesa, CA 92628.

- *Draining the Cooling System.* OL, 010-486-TTS. Available from Career Aids Division, 20417 Nordhoff St., Dept. R 4 5, Chatsworth, CA 91311.

- *Heating and Air Conditioning.* Ford Parts and Service Division M-8669. Available from ASA, P.O. Box 1047, Bedford, TX 76095.

- *Keep Your Car Cool.* MO-706. Available from Teaching Aids, Inc., P.O. Box 1798, Costa Mesa, CA 92628.

- *Principles of Climate Control Air Distribution (Car and Light Truck).* ½" VHS, color, (45:56 min). Covers basics of refrigeration and heat transfer. Shows components and discusses functions; covers electrical system as related to heat and air conditioning. Order No: 3640-006A. Available from Ford Service Publications, P.O. Box 07150, Detroit, MI 48207. To place credit card orders, call 1-800-782-4356.

- *Recharge System.* R-AB139. Available from Teaching Aids, Inc., P.O. Box 1798, Costa Mesa, CA 92628.

- *Refilling the Cooling System.* OL, 010-486-TTS. Available from Career Aids Division, 20417 Nordhoff St., Dept R 4 5, Chatsworth, CA 91311.

NOTE: These films are available to Oklahoma teachers on a free-loan basis. Oklahoma teachers may order these films from the Curriculum and Instructional Materials Center, Oklahoma Department of Vocational and Technical Education, 1500 W. Seventh, Stillwater, Oklahoma 74074. Out-of-state teachers must order these films direct from the company.

UNIT REFERENCES

- Crouse, William H. and Anglin, Donald L. *Automotive Mechanics.* New York, McGraw-Hill Book Company, 1981.

- Dwiggins, Boyce H. *Automotive Air Conditioning.* New York, Delmar Publishers, 1988.

- Mitchell Information Services, Inc. *Mitchell Automechanics.* New Jersey, Prentice Hall, 1982.

- *Automotive Air Conditioning and Heating* 0-02-818620-6 — Glencoe Publishing Company, 1-800-257-5775.

- *Automotive Air Conditioning* 014857-0 — McGraw-Hill Publishing Company. 1-800-334-7344.

PRETEST ANSWERS

HEATING

V

EVALUATOR NOTE

Use the following answer key to check student answers to pretest questions. To determine the student's individual study requirements from pretest results, use the following table which shows the correlation between the objectives and pretest questions. Counsel the students individually on pretest results and study requirements.

TABLE

Correlation between objectives and pretest questions

Objective	Question(s)
1	1, 2
2	3
3	4, 5
4	6
5	7, 8
6	9, 10
7	11
8	12
9	13
10a	14
10b	15
10c	16

ANSWER KEY

1. c
2. a
3. b
4. a
5. c
6. c
7. b
8. c
9. a
10. b
11. c
12. b
13. c
14. a
15. c
16. a

HEATING

NAME ________________________ SCORE ______

DIRECTIONS

Read the following questions and problems. Select the item that best answers the question or problem, and write the correct letter in each blank.

OBJECTIVE 1

_____1. A substance that absorbs heat from matter surrounding it is a(n) ___.

a. absorber
b. heat exchanger
c. coolant

_____2. A device that allows coolant to release heat is a ___.

a. radiator
b. engine block
c. heater hose

OBJECTIVE 2

_____3. The part of the heating system that connects the engine to the heater core is a ___.

a. radiator hose
b. heater hose
c. core hose

OBJECTIVE 3

_____4. Engine coolant ___.

a. enables the heater core to release heat
b. overrides the heater core when it gets too hot
c. must always stay at a constant temperature

_____5. The device that pumps engine coolant through the heating system is a(n) ___.

a. electric pump
b. coolant pump
c. water pump

OBJECTIVE 4

______6. The device that pumps engine coolant through the heating system is driven by ___.

a. electricity
b. a belt to the radiator
c. a belt to the engine

OBJECTIVE 5

______7. Heat given off by the heater core is produced in ___.

a. coils in the core
b. the engine block
c. the radiator

______8. When the function control switch is turned to the HEAT position, ___.

a. heat already being produced in the heater core is allowed into the car
b. coils in the heater core begin to produce heat
c. coolant begins to flow into the heater core

OBJECTIVE 6

______9. If there is no heat coming from the vents of a car, the MOST LIKELY cause is ___.

a. low electrical power level
b. a leaking heater core
c. low coolant level in the engine

_____10. If there is coolant dripping on the floor of the car, the MOST LIKELY cause is a leaking ___.

a. heater core
b. radiator
c. water pump

OBJECTIVE 7

_____11. If you are working on a car and you notice that one heater hose is hot and the other is warm when the engine is running, you know that the ___.

a. heater core is leaking
b. thermostat is always on
c. heater hose is blocked

OBJECTIVE 8

_____12. You are test driving Mrs. Renalt's car. When you turn on the heater, you find that the air coming from the vents is not as hot as it should be. You know that there is ___.

a. moisture in the heater core
b. air in the heater core
c. oil in the heater core

OBJECTIVE 9

_____13. When inspecting a customer's heating system, you notice that extremely hot air is coming from the vents. The engine is also running hot. The problem is that the ___.

a. thermostat is broken
b. coolant level is too high
c. coolant level is too low

OBJECTIVE 10

_____14. When flushing the heater core, a garden hose must be attached ___.

a. after the heater hoses are disconnected
b. before the heater hoses are disconnected
c. after the heater hoses are connected

_____15. After removing the radiator hoses, the technician must ___.

a. drain the radiator
b.. remove the radiator
c. remove the reservoir tube

_____16. When removing the water pump, you must ___.

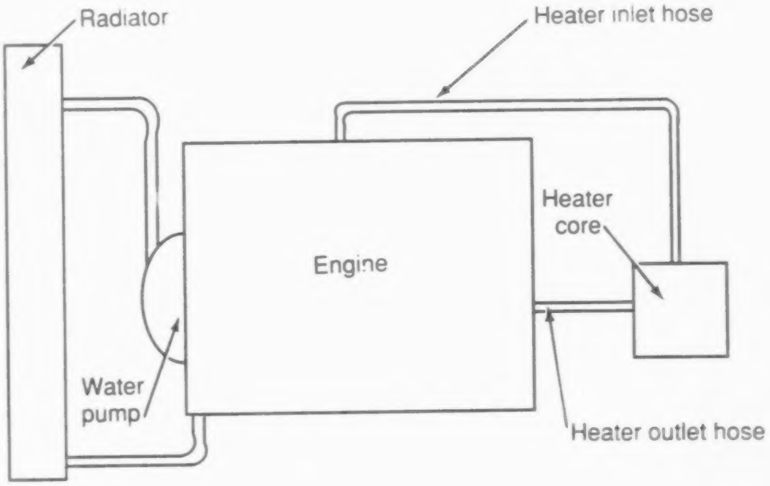
a. remove the radiator before the water pump
b. remove the radiator after the water pump
c. disconnect all electrical connections to the water pump

HEATING

OBJECTIVE 1 **Define terms associated with heating.**

- **Coolant** — A substance that absorbs heat from matter surrounding it.
- **Radiator** — A device that allows coolant to release heat.

OBJECTIVE 2 **Label the components of the heating system.**


Radiator
Heater inlet hose
Heater core
Engine
Water pump
Heater outlet hose

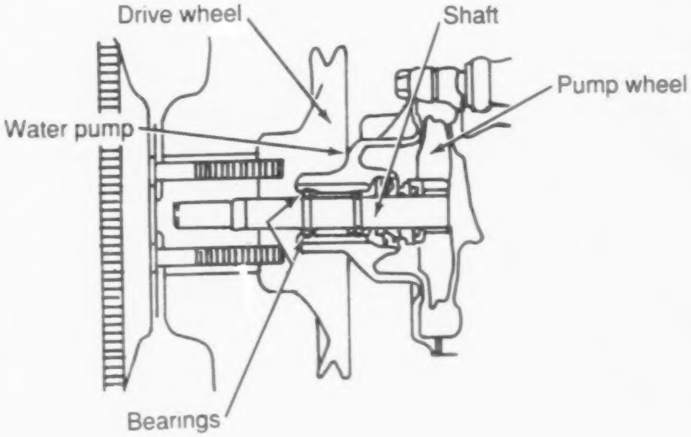
Heating System Components

OBJECTIVE 3 **Match heating components to their functions.**

- **Fan** — Moves warm air around the heater core into the passenger compartment.
- **Heater core** — Allows engine coolant to release heat, thereby warming air around the heater core.

- **Heater inlet hose** — Carries engine coolant from the radiator to the heater core.
- **Heater outlet hose** — Carries engine coolant from the heater core to the radiator.
- **Radiator** — Cools engine coolant.
- **Water pump** — Pumps engine coolant through the heating system.

OBJECTIVE 4 **Label the parts of a water pump.**


Drive wheel
Shaft
Pump wheel
Water pump
Bearings

Water Pump

OBJECTIVE 5

Arrange in order the steps by which the heating system produces hot air.

NOTE: The heating system is not really turned on or off. The heater core is producing hot air even when the air conditioning is on. When the temperature control switch is set toward "HOT," hot air is allowed to enter the car. As the switch is moved toward "COLD," hot air is kept out of the car.

1. The engine produces heat during normal operation.
2. Coolant passing through the engine absorbs heat.
3. Coolant is pumped from the engine into the heating system.
4. Coolant releases heat in the heater core.
5. The released heat warms air surrounding the heater core.
6. Hot air surrounding the heater core is blown into the passenger compartment.
7. Coolant is pumped back into the engine.

HOW THE WATER PUMP AND THERMOSTAT WORK TOGETHER TO KEEP ENGINE COOLANT AT A RELATIVELY CONSTANT TEMPERATURE

When the engine is on, the water pump is constantly pumping coolant through tubes in the engine block, heater hoses, and heater core. As the coolant passes through the engine block, it absorbs heat. When coolant heats to an excessive level, a thermostat opens a passage to the radiator, thereby allowing the coolant to release heat in the radiator and return to the engine block. Eventually, the engine coolant cools to an acceptable level, and the thermostat closes the passage to the radiator.

OBJECTIVE 6 **Match common heating problems to their causes.**

Problem	Causes
1. No heat coming from vents	Fan is broken Air in heater core Clogged heater hose Clogged heater core Low coolant level in engine Broken thermostat
2. Coolant on floor of car	Leaking heater hose Leaking heater core Leaking heater hose connection
3. Odor coming from heater	Leaking heater core
4. Too much heat coming from vents	Broken thermostat Broken temperature control cable
5. When engine is warm and heater is "ON," one heater hose is hot and the other is warm	Blocked heater hose Blocked heater core

ACTIVITY SHEET 1

HEATING

NAME ____________________________

ADVANCES IN HEATING SYSTEMS

Modern auto heating systems use engine coolant to warm air. Have they always done this? Are there any other innovations used in auto heating systems? What other systems could be used to warm air in the car?

ASSIGNMENT SHEET 1

HEATING

V

NAME ______________________________ SCORE ________

OBJECTIVE 7 **Analyze noise and performance.**

INTRODUCTION

The heating system of a car is a collection of components. When these components break, the technician must be able to identify the problem from the effects produced. Odors, lack of heat, or intense heat are among these effects.

DIRECTIONS

Read each problem below. Identify the BEST cause, and write the correct letter in each blank.

______1. Your customer complains that her heater will not warm the air. The first thing you should check is a ___.

a. clogged heater core
b. high level of coolant in the radiator
c. thermostat that is always on

______2. Jane Palombo has brought her car to you for a checkup. When you turn on the engine, you notice that one heater hose is hot and the other is warm. The problem is that the ___.

a. heater core is leaking
b. thermostat is always on
c. heater hose is blocked

______3. The problem described in #2 could also be that the ___.

a. heater hose is leaking
b. heater hose is blocked
c. thermostat is always off

______4. When test driving a customer's car, you notice that cool air is flowing from the vents when the heater is on. You now know that the ___.

a. heater hose is clogged
b. thermostat is stuck open
c. radiator is overfilled

______5. When working under the dash of a customer's car, you smell an odor coming from the heater core. It must have a ___.

a. block in it
b. leak in it
c. lack of coolant in it

ASSIGNMENT SHEET 2

HEATING

V

NAME ____________________ SCORE ________

OBJECTIVE 8 **Diagnose problems.**

INTRODUCTION

The heating system of a car consists of a fan, a heater core, heater hoses, and a radiator. When components break, the technician must be able to identify the problem from the effects produced. A lack or intense amount of heat are among these effects.

DIRECTIONS

Read each problem below. Identify the BEST cause of the problem, and write the correct letter in each blank.

______1. You are test driving Mrs. Goetz's car. When you turn on the heater, you find that the air coming from the vents is not as hot as it should be. You know that there is ___.

a. moisture in the heater core
b. oil in the heater core
c. air in the heater core

______2. When working on a customer's ventilation system, you find that air coming from the vents when the heater is on does not change temperature when the temperature control switch is moved to "COLD." The problem is that the ___.

a. temperature control cable is broken
b. thermostat is stuck on
c. water pump is always running

______3. Mr. Smith brings his car to you. He complains that absolutely no air comes from the vents when the heater is on. The problem is that the ___.

a. heater core is clogged
b. heater hose is broken
c. fan is broken

ASSIGNMENT SHEET 3

HEATING

V

NAME ____________________ SCORE ______

OBJECTIVE 9 **Diagnose cooling-system problems.**

INTRODUCTION

The heating system of a car uses engine coolant to move heat from the engine to the passenger compartment of the car. When one of the components breaks, the effects produced will lead the technician to the problem component. Coolant leaking on the floor of the car, a lack of heat, or an intense amount of heat are among these effects.

DIRECTIONS

Read each problem below. Identify the BEST cause of the problem, and write the correct letter in each blank.

______1. A customer complains that no heat comes from the vent of her car when the heater and fan are on. This means that the ___.

a. coolant level in the radiator is low
b. coolant level in the radiator is high
c. water pump is stuck on

______2. When looking under the dash of a customer's car, you notice engine coolant on the carpet. You ask the owner if it was spilled there, and he says "No." The problem is that the ___.

a. radiator is too full
b. heater core is clogged
c. heater hose is leaking

______3. You have just finished flushing a customer's radiator. When test driving it, you notice that no hot air will come from the heater vents. The problem is that ___.

a. the radiator is overfilled
b. the heater core has water in it
c. the thermostat is broken

______4. When inspecting a customer's heating system, you notice that extremely hot air is coming from the vents. The engine is also running hot. The problem is that the ___.

a. engine coolant level is too high
b. engine coolant level is too low
c. thermostat is broken

______5. You leave a customer's car for a minute to take a break. When you return, you find engine coolant on the floor. Since it was not there before your break, you know that the ___.

a. radiator is overfilled
b. heater core is leaking
c. heater hose is clogged

ASSIGNMENT SHEET 1

1. a
2. c
3. b
4. a
5. b

ASSIGNMENT SHEET 2

1. c
2. a
3. c

ASSIGNMENT SHEET 3

1. a
2. c
3. b
4. b
5. b

JOB SHEET 1

HEATING

V

OBJECTIVE 10a **Flush core.**

TOOLS AND EQUIPMENT

- Eye protection
- Garden hose
- Screwdriver
- Floor drain or container
- Garden hose connector
- Service manual

> **CAUTION**
> **Always** check the procedure in the vehicle's service manual before beginning any service or repair.

PROCEDURE

1. Locate inlet heater hose. (See service manual.)
2. Disconnect clamp on inlet heater hose at the engine block.
3. Remove inlet heater hose from engine block.
4. Place the end of inlet heater hose over drain or container.
5. Locate outlet heater hose. (See service manual.)
6. Disconnect clamp on outlet heater hose at the engine block.
7. Remove outlet heater hose from engine block.
8. Connect outlet heater hose to garden hose.
9. Turn on garden hose.
10. Allow water to run out inlet hose into drain.
11. When water is clear, turn off garden hose.
12. Disconnect garden hose from outlet heater hose.
13. Connect outlet heater hose to engine block.
14. Reconnect clamp on outlet heater hose at engine block.

15. Connect inlet heater hose to engine block.
16. Reconnect clamp on inlet heater hose at engine block.
17. Have your instructor check your work.
18. Put away tools and equipment and clean the work area.

JOB SHEET 2

HEATING

V

OBJECTIVE 10b

Remove and replace radiator.

TOOLS AND EQUIPMENT

- Eye protection
- Screwdriver
- Coolant recycling container
- Wrench
- New radiator
- Service manual

> **CAUTION**
>
> **Always** check the procedure in the vehicle's service manual before beginning any service or repair.

PROCEDURE

1. Park car so radiator is over container.
2. Set brake or parking gear.
3. Locate radiator drain plug. (See service manual.)
4. Open radiator drain plug.

◆ WARNING ◆

If the engine is hot, the coolant coming from the radiator will also be hot.

5. Wait until coolant drains from radiator.
6. Disconnect clamp on upper radiator hose.
7. Remove upper radiator hose from radiator.
8. Disconnect clamp on lower radiator hose.

NOTE: If the car is equipped with an air conditioner, there may also be A/C cooling tubes connected to the radiator. Disconnect these in the same manner as the radiator hoses.

9. Remove lower radiator hose from radiator.

10. Remove tube connecting radiator to radiator reservoir.
11. Remove bolts in radiator mount.
12. Remove radiator from car.
13. Place new radiator in car.
14. Reconnect bolts in radiator mount.
15. Reconnect tube connecting radiator to radiator reservoir.
16. Connect lower radiator hose to radiator.
17. Replace clamp on lower radiator hose.
18. Connect upper radiator hose to radiator.
19. Replace clamp on upper radiator hose.
20. Close drain plug on radiator.
21. Fill radiator with the correct amount of coolant and water. (See service manual.)
22. Have your instructor check your work.
23. Put away tools and equipment and clean the work area.

JOB SHEET 3

HEATING

V

OBJECTIVE 10c

Remove and replace water pump.

TOOLS AND EQUIPMENT

- Eye protection
- Screwdriver
- Floor drain or container
- Wrench
- Gasket
- New water pump
- Service manual

> **CAUTION**
>
> **Always** check the procedure in the vehicle's service manual before beginning any service or repair.

PROCEDURE

1. Remove all belts from engine crankshaft.
2. Remove radiator. (See Job Sheet 2.)
3. Remove fan from engine.
4. Remove bolts in water pump mount.
5. Lift water pump from engine.
6. Remove gasket from engine.
7. Place new gasket on engine.
8. Place new water pump in mount.
9. Replace bolts in water pump mount.
10. Reconnect fan to engine.
11. Replace all belts and adjust tension. (See service manual.)
12. Have your instructor check your work.
13. Put away tools and equipment and clean the work area.

PRACTICAL TEST 1

HEATING

V

JOB SHEET 1

Flush core.

STUDENT'S NAME ____________________ DATE ____________

EVALUATOR'S NAME ____________________ ATTEMPT NO. ______

INSTRUCTIONS

When you are ready to perform this task, ask your instructor to observe the procedure and complete this form. All items listed under "Process Evaluation" must receive a "Yes" for you to receive an acceptable performance evaluation.

PROCESS EVALUATION

Evaluator Note: Place a check mark in the "Yes" or "No" blanks to designate whether or not the student has satisfactorily achieved each step in this procedure. If the student is unable to achieve this competency, have the student review the materials and try again.

The student	YES	NO
1. Located inlet heater hose.	____	____
2. Disconnected clamp on inlet heater hose at the engine block.	____	____
3. Removed inlet heater hose from engine block.	____	____
4. Placed the end of inlet heater hose over drain or container.	____	____
5. Located outlet heater hose.	____	____
6. Disconnected clamp on outlet heater hose at the engine block.	____	____
7. Removed outlet heater hose from engine block.	____	____
8. Connected outlet heater hose to garden hose.	____	____
9. Turned on garden hose.	____	____

	YES	NO
10. Allowed water to run out inlet hose into drain.	____	____
11. When water was clear, turned off garden hose.	____	____
12. Disconnected garden hose from outlet heater hose.	____	____
13. Connected outlet heater hose to engine block.	____	____
14. Reconnected clamp on outlet heater hose at engine block.	____	____
15. Connected inlet heater hose to engine block.	____	____
16. Reconnected clamp on inlet heater hose at engine block.	____	____
17. Used proper tools correctly.	____	____
18. Performed steps in a timely manner.	____	____
19. Practiced safety rules throughout procedure.	____	____
20. Provided satisfactory responses to questions asked.	____	____
21. Put away tools and equipment and cleaned work area.	____	____

EVALUATOR'S COMMENTS ____

____

PRODUCT EVALUATION

Evaluator Note: Rate the student on the following criteria by circling the appropriate numbers. Each criterion must receive a rating of "3" or higher to demonstrate student mastery. (See performance evaluation key.) A student who is unable to demonstrate mastery should review the materials and submit another product for evaluation.

Criteria				
Product meets manufacturer's installation specifications.	4	3	2	1
Product meets manufacturer's adjustment specifications.	4	3	2	1
Product includes proper components/materials.	4	3	2	1
Product meets performance requirements.	4	3	2	1
Product appearance meets industry standards.	4	3	2	1

EVALUATOR'S COMMENTS

AVERAGE RATING

Evaluator Note: To obtain an average rating for the competency profile, total the designated points in "Product Evaluation" and divide by the total number of criteria. Circle the rating on the "Performance Evaluation Key" below.

PERFORMANCE EVALUATION KEY

4 — Skilled — Can perform job with no additional training.
3 — Moderately skilled — Has performed job during training program; limited additional training may be required.
2 — Limited skill — Has performed job during training program; additional training is required to develop skill.
1 — Unskilled — Is familiar with process, but is unable to perform job.

PRACTICAL TEST 2

HEATING

JOB SHEET 2

Remove and replace radiator.

STUDENT'S NAME ____________________ DATE ____________

EVALUATOR'S NAME ____________________ ATTEMPT NO. ______

INSTRUCTIONS

When you are ready to perform this task, ask your instructor to observe the procedure and complete this form. All items listed under "Process Evaluation" must receive a "Yes" for you to receive an acceptable performance evaluation.

PROCESS EVALUATION

Evaluator Note: Place a check mark in the "Yes" or "No" blanks to designate whether or not the student has satisfactorily achieved each step in this procedure. If the student is unable to achieve this competency, have the student review the materials and try again.

The student	YES	NO
1. Parked car so radiator was over drain or container.	____	____
2. Set brake or parking gear.	____	____
3. Located radiator drain plug.	____	____
4. Opened radiator drain plug.	____	____
5. Waited until coolant drained from radiator.	____	____
6. Disconnected clamp on upper radiator hose.	____	____
7. Removed upper radiator hose from radiator.	____	____
8. Disconnected clamp on lower radiator hose.	____	____
9. Removed lower radiator hose from radiator.	____	____

	YES	NO
10. Removed tube connecting radiator to radiator reservoir.	____	____
11. Removed bolts in radiator mount.	____	____
12. Removed radiator from car.	____	____
13. Placed new radiator in car.	____	____
14. Reconnected bolts in radiator mount.	____	____
15. Reconnected tube connecting radiator to radiator reservoir.	____	____
16. Connected lower radiator hose to radiator.	____	____
17. Replaced clamp on lower radiator hose.	____	____
18. Connected upper radiator hose to radiator.	____	____
19. Replaced clamp on upper radiator hose.	____	____
20. Closed drain plug on radiator.	____	____
21. Filled radiator with the correct amount of coolant and water.	____	____
22. Used proper tools correctly.	____	____
23. Performed steps in a timely manner.	____	____
24. Practiced safety rules throughout procedure.	____	____
25. Provided satisfactory responses to questions asked.	____	____
26. Put away tools and equipment and cleaned work area.	____	____

EVALUATOR'S COMMENTS

PRODUCT EVALUATION

Evaluator Note: Rate the student on the following criteria by circling the appropriate numbers. Each criterion must receive a rating of "3" or higher to demonstrate student mastery. (See performance evaluation key.) A student who is unable to demonstrate mastery should review the materials and submit another product for evaluation.

Criteria				
Product meets manufacturer's installation specifications.	4	3	2	1
Product meets manufacturer's adjustment specifications.	4	3	2	1
Product includes proper components/materials.	4	3	2	1
Product meets performance requirements.	4	3	2	1

EVALUATOR'S COMMENTS

____

____

____

AVERAGE RATING

Evaluator Note: To obtain an average rating for the competency profile, total the designated points in "Product Evaluation" and divide by the total number of criteria. Circle the rating on the "Performance Evaluation Key" below.

PERFORMANCE EVALUATION KEY

4 — Skilled — Can perform job with no additional training.
3 — Moderately skilled — Has performed job during training program; limited additional training may be required.
2 — Limited skill — Has performed job during training program; additional training is required to develop skill.
1 — Unskilled — Is familiar with process, but is unable to perform job.

JOB SHEET 3

Remove and replace water pump.

STUDENT'S NAME ________________ DATE ____________

EVALUATOR'S NAME ________________ ATTEMPT NO. ______

INSTRUCTIONS

When you are ready to perform this task, ask your instructor to observe the procedure and complete this form. All items listed under "Process Evaluation" must receive a "Yes" for you to receive an acceptable performance evaluation.

PROCESS EVALUATION

Evaluator Note: Place a check mark in the "Yes" or "No" blanks to designate whether or not the student has satisfactorily achieved each step in this procedure. If the student is unable to achieve this competency, have the student review the materials and try again.

The student	YES	NO
1. Removed all belts from engine crankshaft.	____	____
2. Removed radiator.	____	____
3. Removed fan from engine.	____	____
4. Removed bolts in water pump mount.	____	____
5. Lifted water pump from engine.	____	____
6. Removed gasket from engine.	____	____
7. Placed new gasket on engine.	____	____
8. Placed new water pump in mount.	____	____
9. Replaced bolts in water pump mount.	____	____
10. Reconnected fan to engine.	____	____
11. Replaced all belts and adjusted tension.	____	____
12. Used proper tools correctly.	____	____

	YES	NO
13. Performed steps in a timely manner.	____	____
14. Practiced safety rules throughout procedure.	____	____
15. Provided satisfactory responses to questions asked.	____	____
16. Put away tools and equipment and cleaned work area.	____	____

EVALUATOR'S COMMENTS ____

____

PRODUCT EVALUATION

Evaluator Note: Rate the student on the following criteria by circling the appropriate numbers. Each criterion must receive a rating of "3" or higher to demonstrate student mastery. (See performance evaluation key.) A student who is unable to demonstrate mastery should review the materials and submit another product for evaluation.

Criteria				
Product meets manufacturer's installation specifications.	4	3	2	1
Product meets manufacturer's adjustment specifications.	4	3	2	1
Product includes proper components/materials.	4	3	2	1
Product meets performance requirements.	4	3	2	1
Product appearance meets industry standards.	4	3	2	1

EVALUATOR'S COMMENTS

AVERAGE RATING

Evaluator Note: To obtain an average rating for the competency profile, total the designated points in "Product Evaluation" and divide by the total number of criteria. Circle the rating on the "Performance Evaluation Key" below.

PERFORMANCE EVALUATION KEY

4 — Skilled — Can perform job with no additional training.
3 — Moderately skilled — Has performed job during training program; limited additional training may be required.
2 — Limited skill — Has performed job during training program; additional training is required to develop skill.
1 — Unskilled — Is familiar with process, but is unable to perform job.

WRITTEN TEST

HEATING

V

NAME ______________________ SCORE ______

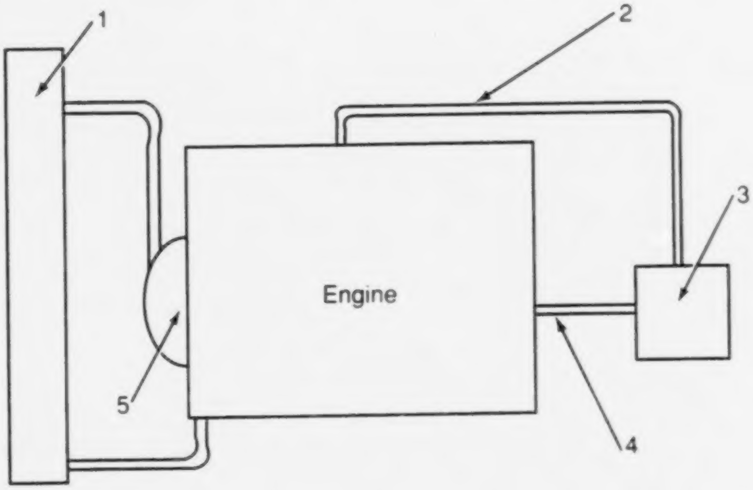
OBJECTIVE 1 **Define terms associated with heating.**

1. **Coolant** — ______________________

2. **Radiator** — ______________________

OBJECTIVE 2 **Label the components of the heating system.**

- Coolant reservoir
- Heater inlet hose
- Heater outlet hose
- Heater core
- Radiator
- Water pump
- Heat pump



Heating System Components

1. ____________________

2. ____________________

3. ____________________

4. ____________________

5. ____________________

OBJECTIVE 3

Match heating components to their functions. Write the correct letter in each blank.

______1. Carries engine coolant from the radiator to the heater core.

______2. Carries engine coolant from the heater core to the radiator.

______3. Cools engine coolant.

______4. Allows engine coolant to release heat, thereby warming air around the heater core.

______5. Moves warm air around the heater core into the passenger compartment.

______6. Pumps engine coolant through the heating system.

a. Heater core

b. Radiator

c. Heater inlet hose

d. Water pump

e. Evaporator

f. Radiator hose

g. Heater outlet hose

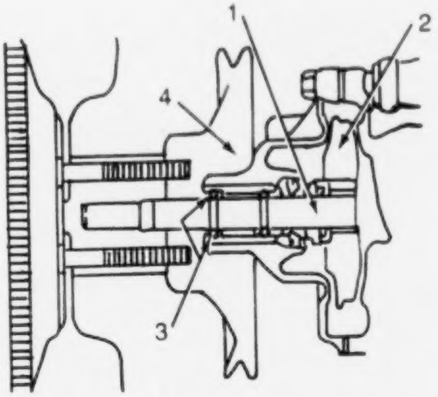
h. Fan

i. Temperature control door

OBJECTIVE 4

Label the parts of a water pump.

- Shaft
- Pump wheel
- Bearings
- Drive wheel
- Bolt



1. ____________________

2. ____________________

3. ____________________

4. ____________________

OBJECTIVE 5

Arrange in order the steps by which the heating system produces hot air. Write a "1" in the blank before the first step, a "2" in the blank before the second step, and so on.

______a. Coolant releases heat in the heater core.

______b. The released heat warms air surrounding the heater core.

______c. Coolant passing through the engine absorbs heat.

______d. Hot air surrounding the heater core is blown into the passenger compartment.

______e. The engine produces heat during normal operation.

______f. Coolant is pumped back into the engine.

______g. Coolant is pumped from the engine into the heating system.

OBJECTIVE 6

Match common heating problems to their causes. Write the correct letter(s) in each blank. Some problems may have more than one cause.

______1. No heat coming from vents

______2. Coolant on floor of car

______3. Odor coming from heater

______4. Too much heat coming from vents

______5. When engine is warm and heater is "ON," one heater hose is hot and the other is warm

a. Blocked heater hose

b. Leaking heater core

c. Leaking heater hose

d. Fan is broken

e. Blocked heater core

f. Clogged heater hose

g. Clogged heater core

h. Leaking heater hose connection

i. Low coolant level in engine

j. Broken thermostat

k. Air in heater core

l. Broken temperature control cable

NOTICE The following assignment sheets and job sheets are not part of the written test. If these activities have not been completed, check with your instructor.

OBJECTIVE 7	**Analyze noise and performance.**	SCORE ______
OBJECTIVE 8	**Diagnose problems.**	SCORE ______
OBJECTIVE 9	**Diagnose cooling-system problems.**	SCORE ______
OBJECTIVE 10a	**Flush core.**	RATING ______
OBJECTIVE 10b	**Remove and replace radiator.**	RATING ______
OBJECTIVE 10c	**Remove and replace water pump.**	RATING ______

WRITTEN TEST ANSWERS

HEATING

V

OBJECTIVE 1

1. A substance that absorbs heat from matter surrounding it.
2. A device that allows coolant to release heat.

OBJECTIVE 2

1. Radiator
2. Heater inlet hose
3. Heater core
4. Heater outlet hose
5. Water pump

OBJECTIVE 3

1. c
2. g
3. b
4. a
5. h
6. d

OBJECTIVE 4

1. Shaft
2. Pump wheel
3. Bearings
4. Drive wheel

OBJECTIVE 5

1. e
2. c
3. g
4. a
5. b
6. d
7. f

OBJECTIVE 6

1. d, f, g, i, j, k
2. b, c, h
3. b
4. j, l
5. a, e

OBJECTIVE 7 Refer to answers to Assignment Sheet 1.

OBJECTIVE 8 Refer to answers to Assignment Sheet 2.

OBJECTIVE 9 Refer to answers to Assignment Sheet 3.

OBJECTIVE 10 Refer to Practical Test ratings for Job Sheets 1 - 3.

OBJECTIVE SHEET

AUTOMATIC AND SEMI-AUTOMATIC CONTROLS

VI

INTRODUCTION

The driver who uses manual temperature controls must constantly adjust the temperature control lever in order to achieve maximum comfort. In some cars, however, these adjustments are made by automatic controls. A computer receives information from various sensors in the car, decides how much cold or hot air is needed, and adjusts the heating or air conditioning system appropriately. In this way, the operator need only choose heat or A/C and the comfortable temperature. With a semi-automatic system, the driver must also adjust fan speed. With an automatic system, all decisions are made by the computer.

UNIT OBJECTIVE

After completing this unit, the student should be familiar with the general layout of an automatic system, be able to distinguish an automatic system from a manual one, and have the ability to perform routine maintenance procedures. The student will demonstrate these competencies by completing assignment sheets, job sheets, practical tests, and the written test with a minimum of 85 percent accuracy.

PREREQUISITE

The student must have successfully completed the core curriculum, *Introduction to Automotive Service, Electrical Systems Specialist,* Units I-V.

SPECIFIC OBJECTIVES

After completing this unit, the student should be able to

1. List the components of automatic controls.
2. Label the components of an automatic and a semi-automatic system.
3. Match the components of automatic or semi-automatic controls to their functions.
4. Complete a chart that compares automatic and manual systems.
5. Name sensors and switches that are required for an automatic system.
6. Interpret system diagrams. (Assignment Sheet 1)
7. Diagnose problems. (Assignment Sheet 2)

8. Demonstrate the ability to:

   a. Inspect and replace a sensor. (Job Sheet 1)

   b. Inspect and replace a switch. (Job Sheet 2)

SUGGESTED ACTIVITIES

AUTOMATIC AND SEMI-AUTOMATIC CONTROLS VI

PREPARATION

- Review unit and plan presentation.
- Give pretest.
- Determine scope and sequence of objectives that you add. Design and develop support materials, including evaluation techniques, for additional objectives.
- Review teaching suggestions and plan classroom activities.
- Determine how you will schedule time for students to demonstrate competence in the required procedures.
- Order materials to supplement unit.
- Invite a local auto mechanic to speak to the class.

  NOTE: Supply guest speakers with the Objective Sheet, Information Sheet, and any other components you want them to cover.

DELIVERY

Objective 1 List the components of automatic controls.

- Note that the automatic control head differs in that the temperature control switch has degrees of temperature rather than a scale from hot to cold.

Objectives 2 and 3 Label the components of an automatic and semi-automatic system. Match the components of automatic or semi-automatic controls to their functions.

- Note that many of these devices are covered in Unit II.
- Stress the importance of the computer since all information goes to it.
- Explain that while the operator controls vacuum motors in the manual system, the computer controls them in an automatic one.

Objective 4 Complete a chart that compares automatic and manual systems.

- Note that the major difference is that the temperature control door is controlled through the computer by a vacuum motor.

Objective 5 Name sensors and switches that are required for an automatic system.

- Explain that the most important sensors will be in every automatic system.

APPLICATION

Objective 6 Interpret system diagrams. (Assignment Sheet 1)
Objective 7 Diagnose problems. (Assignment Sheet 2)

- Use the assignment sheets to help students interpret system diagrams and diagnose problems.

Objective 8 Demonstrate the ability to:

- Inspect and replace a sensor. (Job Sheet 1)
- Inspect and replace a switch. (Job Sheet 2)
- Use Job Sheets 1 and 2 to teach students to perform maintenance procedures correctly.

EVALUATION

Pretest

- Pretest qualifying students.
- Determine individual requirements from pretest results.
- Counsel students individually on pretest results and study requirements.

Practical Test

- Explain to students that they will be asked to demonstrate procedures on the job sheets to complete the practical tests.
- Describe the rating scale used on the practical tests.
- Reteach and retest as necessary.

Written Test

- Explain to students that they will be asked to demonstrate on the written test actions listed in the specific objectives.
- Give written test.

  NOTE: The written test may be given in sections if desired.
- Evaluate students on assignment sheet activities if not previously done.
- Reteach and retest if necessary.
- Complete appropriate section of competency profiles.
- Review individual and group performance in order to evaluate teaching methods. Adjust scope, sequence, or instructional approaches for additional lessons as required.

SUGGESTED RESOURCES

Publications

- *Auto Heating and Air Conditioning Manual 1989: Motor/Age Professional Mechanic's Edition.* Full coverage for 1987-89 selected domestic cars and light trucks, popular import cars. Order No. 7963. Call Chilton Book Company, School and Library Division, 1-800-345-1214, extension 4729.
- *Chilton's Guide to Air Conditioning Repair and Service.* Basic procedures for diagnosis, service, and repair; vacuum and wiring schematics on A/C systems in 1982-85 domestic cars, light trucks and popular imports. Order No. ISBN 0-8019-s7580-8. Call Chilton Book Company, School and Library Division, 1-800-345-1214, extension 4729.

Media

- *Air Conditioning Compressor Seal Service.* OL, MI-8011V-TTS. Available from Career Aids Division, 20417 Nordhoff St., Dept. R 4 5, Chatsworth, CA 91311.
- *Air Conditioning Diagnosis.* OL, MI-8009V-TTS. Available from Career Aids Division, 20417 Nordhoff St., Dept. R 4 5, Chatsworth, CA 91311.

- *Air Conditioning Performance Testing.* Chrysler Corporation. M-8671. Available from ASA. P.O. Box 1047. Bedford. TX 76095.
- *Air Conditioning System.* Ford Parts and Service Division, M-8001. Available from ASA. P.O. Box 1047. Bedford. TX 76095.
- *Automotive Air Conditioning Explained.* B-442X. Available from Teaching Aids, Inc., P.O. Box 1798. Costa Mesa. CA 92628.
- *Automotive Air Conditioning Service.* OL. MI-8008V-TTS. Available from Career Aids Division. 20417 Nordhoff St., Dept R 4 5. Chatsworth, CA 91311.
- *The Automotive Air Conditioner.* Set of 3 VHS cassettes. VHS 1. *Basic Parts and Principles* (17:52 min) addresses principles of air conditioning and identifies components and their functions. Demonstrates flow of freon through the system. VHS 2. *Using the Equipment.* (18:00 min) covers major equipment and tools used in air conditioning maintenance and repair; shows procedures for checking pressure, using freon, finding freon leaks. VHS 3, *Troubleshooting Problems,* (14:02 min) shows students how to detect freon leaks, how to troubleshoot, and how to correct problems. Videotapes can be purchased separately. Available from Bergwall Video Productions, Inc., 1-800-645-3565.
- *The Automotive Cooling System.* 406X-V11. Available from Bergwall Video Productions, Inc., P.O. Box 238. Garden City, NY 11530.
- *Basic Air Conditioning Systems.* OL. MI-8010V-TTS. Available from Career Aids Division. 20417 Nordhoff St., Dept. R 4 5. Chatsworth, CA 91311.
- *Discharge and Evaluation.* R-AB138. Available from Teaching Aids, Inc., P.O. Box 1798. Costa Mesa. CA 92628.
- *Draining the Cooling System.* OL. 010-486-TTS. Available from Career Aids Division. 20417 Nordhoff St., Dept. R 4 5. Chatsworth, CA 91311.

- *Heating and Air Conditioning.* Ford Parts and Service Division M-8669. Available from ASA, P.O. Box 1047, Bedford, TX 76095.
- *Keep Your Car Cool.* MO-706. Available from Teaching Aids, Inc., P.O. Box 1798, Costa Mesa, CA 92628.
- *Principles of Climate Control Air Distribution (Car and Light Truck).* ½" VHS, color, (45:56 min). Covers basics of refrigeration and heat transfer. Shows components and discusses functions; covers electrical system as related to heat and air conditioning. Order No: 3640-006A. Available from Ford Service Publications, P.O. Box 07150, Detroit, MI 48207. To place credit card orders, call 1-800-782-4356.
- *Recharge System.* R-AB139. Available from Teaching Aids, Inc., P.O. Box 1798, Costa Mesa, CA 92628.
- *Refilling the Cooling System.* OL. 010-486-TTS. Available from Career Aids Division, 20417 Nordhoff St., Dept R 4 5, Chatsworth, CA 91311.

NOTE: These films are available to Oklahoma teachers on a free-loan basis. Oklahoma teachers may order these films from the Curriculum and Instructional Materials Center, Oklahoma Department of Vocational and Technical Education, 1500 W. Seventh, Stillwater, Oklahoma 74074. Out-of-state teachers must order these films direct from the company.

UNIT REFERENCES

- Crouse, William H. and Anglin, Donald L. *Automotive Mechanics.* New York, McGraw-Hill Book Company, 1981.
- Dwiggins, Boyce H., *Automotive Air Conditioning.* New York, Delmar Publishers, 1988.
- Mitchell Information Services, Inc., *Mitchell Automechanics.* New Jersey, Prentice Hall, 1982.
- *Automotive Air Conditioning and Heating* 0-02-818620-6 — Glencoe Publishing Company, 1-800-257-5775.
- *Automotive Air Conditioning* 014857-0, McGraw-Hill Publishing Company, 1-800-334-7344.

PRETEST ANSWERS

AUTOMATIC AND SEMI-AUTOMATIC CONTROLS VI

NAME ____________________ SCORE ______

EVALUATOR NOTE

Use the following answer key to check student answers to pretest questions. To determine the student's individual study requirements from pretest results, use the following table, which shows the correlation between the objectives and pretest questions. Counsel the students individually on pretest results and study requirements.

TABLE

Correlation between objectives and pretest questions

Objective	Question(s)
1	1
2	2, 3
3	4, 5, 6, 7
4	8, 9
5	10, 11
6	12
7	13
8	14, 15

ANSWER KEY

1. c
2. a
3. c
4. b
5. a
6. c
7. a
8. c
9. c
10. a
11. b
12. b
13. c
14. a
15. c

PRETEST

AUTOMATIC AND SEMI-AUTOMATIC CONTROLS

VI

NAME ________________________________ SCORE ________

DIRECTIONS

Read the following questions and problems. Select the item that best answers the question or problem, and write the correct letter in each blank.

OBJECTIVE 1

______1. The temperature control switch on an automatic system allows the operator to set the temperature to ___.

a. a hot to cold setting
b. temperatures in 10-degree increments
c. a specific temperature

OBJECTIVE 2

______2. The temperature control door in an automatic system is controlled by a ___.

a. computer
b. cable from the temperature control switch
c. vacuum line from the temperature control switch

______3. Airflow doors in an automatic system are controlled by a ___.

a. vacuum line from the function control switch
b. cable from the function control switch
c. computer

OBJECTIVE 3

______4. A safety device that tells the computer when outside temperature falls below 32 degrees Fahrenheit is the ___.

a. outside temperature sensor
b. ambient sensor
c. freezing sensor

______5. The sensor that sends the temperature reading in the interior of the car to the computer is the ___.

a. in-car sensor
b. car temperature sensor
c. interior sensor

______6. The sensor that sends information about the amount of sunlight hitting the car to the computer is the ___.

a. sunlight detector
b. light sensor
c. sunload sensor

______7. The computer will turn off the heat when the engine coolant temperature is ___.

a. relatively cold
b. relatively hot
c. at acceptable levels

OBJECTIVE 4

______8. In an automatic system, all airflow doors are controlled by either a ___.

a. vacuum line or a cable
b. cable or a servo-motor
c. vacuum line or a servo-motor

______9. In an automatic system, the temperature control door is controlled by either a ___.

a. vacuum line or a cable
b. cable or a servo-motor
c. vacuum line or a servo-motor

OBJECTIVE 5

_____10. One sensor found in all automatic systems is the ___.

a. ambient sensor
b. vehicle speed sensor
c. outside temperature sensor

_____11. A sensor found in some automatic systems is the ___.

a. in-car sensor
b. engine temperature sensor
c. low pressure switch

OBJECTIVE 6

_____12. The computer in an automatic system uses information obtained from the inputs to adjust the ___.

a. temperature control door
b. entire heating and cooling system
c. fan speed

OBJECTIVE 7

_____13. When working on a customer's car, you notice that the air conditioning will not turn off when the temperature in the car falls below that on the temperature control switch. The problem is that the ___.

a. engine temperature sensor is broken
b. sunload sensor is broken
c. in-car sensor is broken

OBJECTIVE 8

_____14. When inspecting and replacing sensors, a technician must always ___.

a. check for bad wires before attaching the ohmmeter
b. disconnect the battery before attaching the ohmmeter
c. reconnect the battery before attaching the ohmmeter

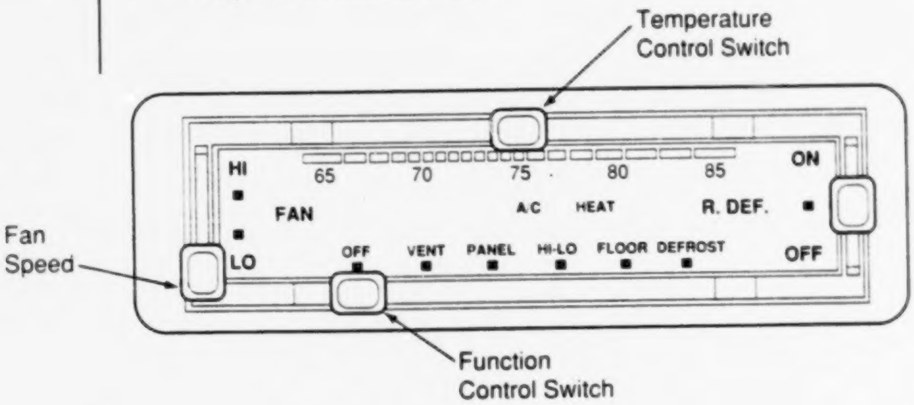
_____15. When replacing automatic system switches, a technician must first ___.

a. discharge the air conditioning system
b. run the engine until it is at a normal temperature
c. disconnect the battery

OBJECTIVE 1

List the components of automatic controls.

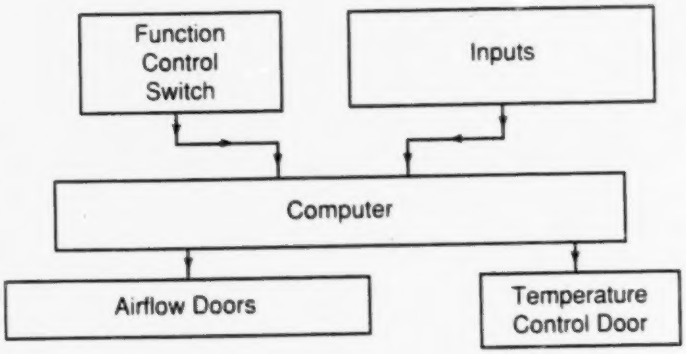
- Fan speed
- Function control switch
- Temperature control switch


Temperature Control Switch
HI
65
70
75
80
85
ON
FAN
A/C
HEAT
R. DEF.
Fan Speed
LO
OFF
VENT
PANEL
HI-LO
FLOOR
DEFROST
OFF
Function Control Switch

Automatic control head assembly

OBJECTIVE 2

Label the components of an automatic and a semi-automatic system.


Function Control Switch
Inputs
Computer
Airflow Doors
Temperature Control Door

A typical automatic system

OBJECTIVE 3

Match the components of automatic or semi-automatic controls to their functions.

- **Ambient sensor** — A safety device that tells the computer when outside temperature falls below 32 degrees Fahrenheit.

  NOTE: Operation of the air conditioning system below freezing temperatures might damage compressor seals.

- **Computer** — Receives information from all sensors and adjusts the temperature control door accordingly.

- **Control head assembly** — Allows the operator to choose A/C, heating, and fan-speed settings and to set the temperature.

- **Engine temperature sensor** — Sends the engine coolant temperature reading to the computer.

  NOTE: This sensor will move the temperature control door toward cold if the engine coolant is cold. This lets the engine warm up faster by keeping heat in the engine coolant.

HOW SENSORS WORK WITH THE COMPUTER

If the in-car sensor temperature is higher than the one selected by the temperature control switch, the computer will move the temperature control door toward cold. This allows more cold air from the evaporator (if the A/C is on) and less hot air from the heater core to flow into the car. If the in-car temperature is lower than the one selected by the temperature control switch, the computer will move the temperature control door toward "HOT." This allows less cold air from the evaporator (if the A/C is on) and more hot air from the heater core to flow into the car.

- **High-side temperature switch** — Sends the refrigerant temperature reading on the high-side of the refrigeration system to the computer.

- **In-car sensor** — Sends the temperature reading of the interior of the car to the computer.

- **Low-pressure switch** — A safety device that tells the computer when refrigerant temperature is too low.

  NOTE: A low refrigerant level means that some oil is lost. A low level of oil would damage the compressor.

- **Low-side temperature switch** — Sends the refrigerant temperature reading on the low-side of the refrigeration system to the computer.

- **Outside temperature sensor** — Sends the temperature reading on the exterior of the car to the computer.

  NOTE: This sensor operates in a manner similar to that of the in-car temperature sensor.

- **Sunload sensor** — Sends information about the amount of sunlight hitting the car to the computer.

  NOTE: The sunload sensor works much like the in-car sensor.

- **Vehicle speed sensor** — Sends information about the speed of the vehicle to the computer.

  NOTE: Information from the vehicle speed sensor allows the computer to adjust information from other sensors that are affected by speed.

OBJECTIVE 4

Complete a chart that compares automatic and manual systems.

Component	Manual system	Automatic system
Temperature control switch	Set on a scale of "HOT" to "COLD"	Set to a specific temperature
Temperature control door	Controlled by a cable	Controlled by a vacuum motor **NOTE:** On some automatic systems, the temperature control door is controlled by a servo-motor attached to it.

Component	Manual system	Automatic system
Vacuum motors function control airflow doors	Controlled by the pressure on switch	Computer adjusts vacuum that adjust air on all vacuum motors **NOTE:** On some automatic systems, the computer adjusts a servo-motor attached to the airflow doors.

OBJECTIVE 5 **Name sensors and switches that are required for an automatic system.**

- Ambient sensor
- In-car sensor
- Low-pressure switch

ACTIVITY SHEET 1

AUTOMATIC AND SEMI-AUTOMATIC CONTROLS

VI

NAME ______________________________

ADVANCES IN AUTOMATIC SYSTEMS

Each automatic system is different. Over the years, different sensors have been added. Refer to old service manuals to find out what sensors have been added. How has each made the system better at maintaining passenger comfort? How many have become obsolete?

ASSIGNMENT SHEET 1

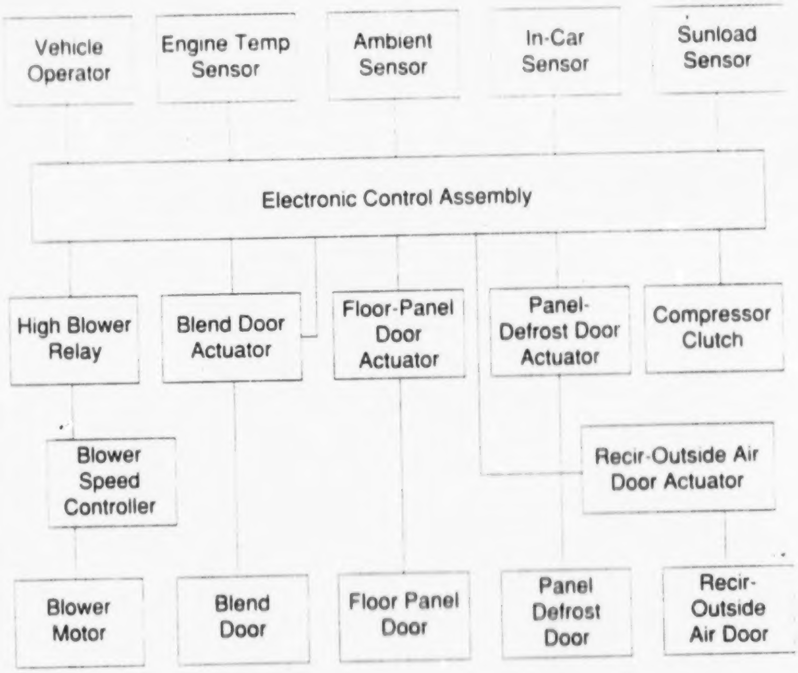
AUTOMATIC AND SEMI-AUTOMATIC CONTROLS VI

NAME ______________________________ SCORE ______

OBJECTIVE 6 **Interpret system diagrams.**

INTRODUCTION Each of the many components in an automatic system performs a vital function. A system diagram helps the technician know which components the system contains. This is essential information when performing system diagnosis.

DIRECTIONS Use the system diagram to answer the questions. Write the correct letter in each blank.


Vehicle Operator
Engine Temp Sensor
Ambient Sensor
In-Car Sensor
Sunload Sensor
Electronic Control Assembly
High Blower Relay
Blend Door Actuator
Floor-Panel Door Actuator
Panel-Defrost Door Actuator
Compressor Clutch
Blower Speed Controller
Recir-Outside Air Door Actuator
Blower Motor
Blend Door
Floor Panel Door
Panel Defrost Door
Recir-Outside Air Door

______1. The input "VEHICLE OPERATOR" refers to ___.

a. whether the operator is too hot or too cold
b. the settings on the control head assembly
c. the setting of the temperature control switch

______2. The number of sensors in the system is ___.

a. five
b. six
c. four

______3. The electronic control assembly uses the information obtained from the inputs to adjust the ___.

a. blower, temperature control door, panel door, floor/defrost door, and recirculation door and compressor
b. temperature control door, panel door, floor/defrost door, and recirculation door and compressor
c. blower, temperature control door, panel door, floor/defrost door, and recirculation door (the recirculation door is only controlled when the compressor is on)

______4. The control head is set to "HEAT," "HIGH" fan speed, and 75 degrees Fahrenheit. If the engine temperature sensor reads low, the electronic control assembly will ___.

a. close the temperature control door to stop heat from coming in the car
b. open the temperature control door to let heat enter the car
c. set the fan speed to high until the engine warms up

______5. The control head is set to "A/C Max," "HIGH" fan speed, and 75 degrees Fahrenheit. If the in-car sensor reads 80 degrees Fahrenheit, the electronic control assembly will ___.

a. close the recirculation door to keep outside air out, set the fan to high, and close the temperature control door to keep heat out
b. close the recirculation door to keep outside air out, set the fan to high, turn the compressor off, and close the temperature control door to keep heat out
c. close the recirculation door to keep outside air out, set the fan to high, turn the compressor on, and close the temperature control door to keep heat out

ASSIGNMENT SHEET 2

AUTOMATIC AND SEMI-AUTOMATIC CONTROLS

VI

NAME ______________________________ SCORE ________

OBJECTIVE 7 **Diagnose problems.**

INTRODUCTION In order for the automatic system to work properly, all components must be in good working order. Sometimes, one or more components may break, causing the system to malfunction. A skilled technician must be able to locate the component and fix it in order to bring the system back into proper operation.

DIRECTIONS For each of the situations below, choose the BEST diagnosis for the given problem. Write the correct letter in each blank.

______1. You are working on a customer's car. You notice that the air conditioning always runs, even when the temperature in the car falls below that on the temperature control switch. The problem is that the ___.

a. in-car sensor is broken
b. sunload sensor is broken
c. engine temperature sensor is broken

______2. A customer complains that the heater always runs at any position of the function control switch. The problem is most likely in the ___.

a. low-side temperature switch
b. engine temperature sensor
c. computer

______3. You notice that your customer's car always seems hot when the sun is bright. The problem is most likely in the ___.

a. vehicle speed sensor
b. sunload sensor
c. engine temperature sensor

______4. Your customer is complaining that the heater never works in the car. The problem is most likely in the ___.

a. engine temperature switch
b. sunload sensor
c. high-side temperature switch

______5. A customer complains that the fan speed in the car will not adjust when the car gets cool. The problem is most likely in the ___.

a. compressor switch
b. computer
c. engine temperature sensor

ASSIGNMENT ANSWERS — AUTOMATIC AND SEMI-AUTOMATIC CONTROLS VI

ASSIGNMENT SHEET 1

1. b
2. c
3. a
4. a
5. c

ASSIGNMENT SHEET 2

1. a
2. c
3. b
4. a
5. b

JOB SHEET 1

AUTOMATIC AND SEMI-AUTOMATIC CONTROLS

VI

OBJECTIVE 8a

Inspect and replace a sensor.

NOTE: Sensors include engine temperature, ambient, in-car, vehicle speed, and sunload.

TOOLS AND EQUIPMENT

- Volt ohmmeter (VOM)
- Screwdriver
- Owner's manual
- New sensor
- Service manual

> **CAUTION**
>
> **Always** check the procedure in the vehicle's service manual before beginning any service or repair.

PROCEDURE 1

Inspect a sensor.

1. Locate the sensor to be inspected. (See service manual.)

   NOTE: If the sensor is mounted in the dash, parts of the dash may have to be removed. (See service manual.)

2. Check wires for split casing.
3. Check wire attachments to the sensor for solid connections.
4. Attach VOM to sensor.
5. Compare reading on VOM to service manual specification.
6. If any wires or connections are bad, report them to your instructor.
7. If the ohmmeter reading differs from the owner's manual specification, perform procedure 2.
8. Put away tools and equipment and clean work area.

PROCEDURE 2

Replace a sensor.

1. Disconnect the power source.
2. Note where the positive and negative wires are attached to the sensor.
3. Disconnect positive and negative wires from sensor.
4. Remove the sensor from its mounting hardware.
5. Place sensor in mounting hardware.
6. Reconnect positive and negative wires.

CAUTION

Be sure to connect the wires to the correct terminal on the sensor.

7. Have your instructor check your work.
8. Reconnect the power source.
9. Have your instructor check your work.
10. Put away tools and equipment and clean the work area.

OBJECTIVE 8b **Inspect and replace a switch.**

NOTE: This applies to the low-side temperature switch, high-side temperature switch, and low pressure switch.

TOOLS AND EQUIPMENT

- Volt ohmmeter (VOM)
- Screwdriver
- New switch
- Service manual

CAUTION

Always check the procedure in the vehicle's service manual before beginning any service or repair.

PROCEDURE 1 **Inspect a switch.**

1. Locate the switch to be inspected. (See service manual.)

   NOTE: If the switch is mounted in the dash, parts of the dash may have to be removed. (See service manual.)

2. Check wires for split casing.
3. Check wire attachments to the switch for solid connections.
4. Attach VOM to switch.
5. Compare reading on VOM to service manual specification.
6. If any wires or connections are bad, report them to your instructor.
7. If the VOM reading differs from the owner's manual specification, perform procedure 2.
8. Put away tools and equipment and clean work area.

PROCEDURE 2 **Replace a switch.**

1. Disconnect the power source.

2. Note where the positive and negative wires are attached to the switch.
3. Disconnect positive and negative wires from switch.
4. Remove the switch from its mounting hardware.
5. Place switch in mounting hardware.
6. Reconnect positive and negative wires.

CAUTION

Be sure to connect the wires to the correct terminal on the switch.

7. Have your instructor check your work.
8. Reconnect the power source.
9. Have your instructor check your work.
10. Put away tools and equipment and clean the work area.

JOB SHEET 1

Inspect and replace a sensor.

STUDENT'S NAME ____________________ DATE ______________

EVALUATOR'S NAME ____________________ ATTEMPT NO. ______

INSTRUCTIONS

When you are ready to perform this task, ask your instructor to observe the procedure and complete this form. All items listed under "Process Evaluation" must receive a "Yes" for you to receive an acceptable performance evaluation.

PROCESS EVALUATION

Evaluator Note: Place a check mark in the "Yes" or "No" blanks to designate whether or not the student has satisfactorily achieved each step in this procedure. If the student is unable to achieve this competency, have the student review the materials and try again.

The student	YES	NO
Procedure 1: Inspected a sensor.		
1. Located the sensor to be inspected.	_____	_____
2. Checked wires for split casing.	_____	_____
3. Checked wire attachments to the sensor for solid connections.	_____	_____
4. Attached VOM to sensor.	_____	_____
5. Compared reading on VOM to service manual specification.	_____	_____
6. If any wires or connections were bad, reported them to instructor.	_____	_____
7. If the VOM reading differed from owner's manual specification, performed procedure 2.	_____	_____
8. Used proper tools correctly.	_____	_____
9. Performed steps in a timely manner.	_____	_____

	YES	NO
10. Practiced safety rules throughout procedure.	____	____
11. Provided satisfactory responses to questions asked.	____	____
12. Put away tools and equipment and cleaned work area.	____	____

Procedure 2: Replaced a sensor.

1. Disconnected the power source.	____	____
2. Noted where the positive and negative wires were attached to the sensor.	____	____
3. Disconnected positive and negative wires from sensor.	____	____
4. Removed the sensor from its mounting hardware.	____	____
5. Placed sensor in mounting hardware.	____	____
6. Reconnected positive and negative wires.	____	____
7. Reconnected the power source.	____	____
8. Used proper tools correctly.	____	____
9. Performed steps in a timely manner.	____	____
10. Practiced safety rules throughout procedure.	____	____
11. Provided satisfactory responses to questions asked.	____	____
12. Put away tools and equipment and cleaned work area.	____	____

EVALUATOR'S COMMENTS ________________________________

____

PRODUCT EVALUATION

Evaluator Note: Rate the student on the following criteria by circling the appropriate numbers. Each criterion must receive a rating of "3" or higher to demonstrate student mastery. (See performance evaluation key.) A student who is unable to demonstrate mastery should review the materials and submit another product for evaluation.

Criteria				
Product meets manufacturer's installation specifications.	4	3	2	1
Product meets manufacturer's adjustment specifications.	4	3	2	1
Product includes proper components/materials.	4	3	2	1
Product meets performance requirements.	4	3	2	1
Product appearance meets industry standards.	4	3	2	1

EVALUATOR'S COMMENTS

AVERAGE RATING

Evaluator Note: To obtain an average rating for the competency profile, total the designated points in "Product Evaluation" and divide by the total number of criteria. Circle the rating on the "Performance Evaluation Key" below.

PERFORMANCE EVALUATION KEY

4 — Skilled — Can perform job with no additional training.
3 — Moderately skilled — Has performed job during training program; limited additional training may be required.
2 — Limited skill — Has performed job during training program; additional training is required to develop skill.
1 — Unskilled — Is familiar with process, but is unable to perform job.

PRACTICAL TEST 2

AUTOMATIC AND SEMI-AUTOMATIC CONTROLS

VI

JOB SHEET 2

Inspect and replace a switch.

STUDENT'S NAME ____________ DATE ____________

EVALUATOR'S NAME ____________ ATTEMPT NO. ______

INSTRUCTIONS

When you are ready to perform this task, ask your instructor to observe the procedure and complete this form. All items listed under "Process Evaluation" must receive a "Yes" for you to receive an acceptable performance evaluation.

PROCESS EVALUATION

Evaluator Note: Place a check mark in the "Yes" or "No" blanks to designate whether or not the student has satisfactorily achieved each step in this procedure. If the student is unable to achieve this competency, have the student review the materials and try again.

The student	YES	NO
Procedure 1: Inspected a switch.		
1. Located the switch to be inspected.	____	____
2. Checked wires for split casing.	____	____
3. Checked wire attachments to the switch for solid connections.	____	____
4. Attached VOM to switch.	____	____
5. Compared reading on VOM to service manual specification.	____	____
6. If any wires or connections were bad, reported them to instructor.	____	____
7. If the VOM reading differed from service manual specification, performed procedure 2.	____	____
8. Used proper tools correctly.	____	____
9. Performed steps in a timely manner.	____	____

	YES	NO
10. Practiced safety rules throughout procedure.	____	____
11. Provided satisfactory responses to questions asked.	____	____
12. Put away tools and equipment and cleaned work area.	____	____

Procedure 2: Replaced a switch.

1. Disconnected the power source.	____	____
2. Noted where the positive and negative wires were attached to the switch.	____	____
3. Disconnected positive and negative wires from switch.	____	____
4. Removed the switch from its mounting hardware.	____	____
5. Placed switch in mounting hardware.	____	____
6. Reconnected positive and negative wires.	____	____
7. Reconnected the power source.	____	____
8. Used proper tools correctly.	____	____
9. Performed steps in a timely manner.	____	____
10. Practiced safety rules throughout procedure.	____	____
11. Provided satisfactory responses to questions asked.	____	____
12. Put away tools and equipment and cleaned work area.	____	____

EVALUATOR'S COMMENTS ______________________________

____

PRODUCT EVALUATION

Evaluator Note: Rate the student on the following criteria by circling the appropriate numbers. Each criterion must receive a rating of "3" or higher to demonstrate student mastery. (See performance evaluation key.) A student who is unable to demonstrate mastery should review the materials and submit another product for evaluation.

Criteria				
Product meets manufacturer's installation specifications.	4	3	2	1
Product meets manufacturer's adjustment specifications.	4	3	2	1
Product includes proper components/materials.	4	3	2	1
Product meets performance requirements.	4	3	2	1
Product appearance meets industry standards.	4	3	2	1

EVALUATOR'S COMMENTS

AVERAGE RATING

Evaluator Note: To obtain an average rating for the competency profile, total the designated points in "Product Evaluation" and divide by the total number of criteria. Circle the rating on the "Performance Evaluation Key" below.

PERFORMANCE EVALUATION KEY

4 —	Skilled — Can perform job with no additional training.
3 —	Moderately skilled — Has performed job during training program; limited additional training may be required.
2 —	Limited skill — Has performed job during training program; additional training is required to develop skill.
1 —	Unskilled — Is familiar with process, but is unable to perform job.

WRITTEN TEST

AUTOMATIC AND SEMI-AUTOMATIC CONTROLS

VI

NAME ______________________ SCORE ________

OBJECTIVE 1

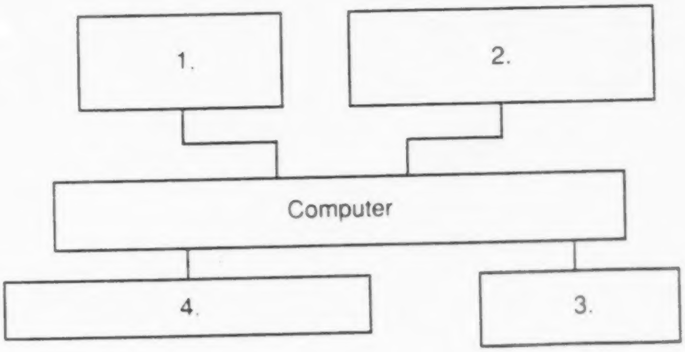
List the components of automatic controls.

1. ______________________
2. ______________________
3. ______________________

OBJECTIVE 2

Label the components of an automatic and a semi-automatic system.

- Inputs
- Outputs
- Airflow doors
- Function control switch
- Temperature control door



1. ______________
2. ______________
3. ______________
4. ______________

OBJECTIVE 3

Match the components of automatic or semi-automatic controls to their functions. Write the correct letter in each blank.

______1. Sends the temperature reading of the interior of the car to the computer.

______2. Sends the temperature reading on the exterior of the car to the computer.

______3. Allows the operator to choose A/C, heating, and fan-speed settings and to set the temperature.

______4. Receives information from all sensors and adjusts the temperature control door accordingly.

______5. Sends information about the amount of sunlight hitting the car to the computer.

______6. Sends information about the speed of the vehicle to the computer.

______7. A safety device that tells the computer when outside temperature falls below 32 degrees Fahrenheit.

______8. A safety device that tells the computer when refrigerant temperature is too low.

______9. Sends the refrigerant temperature reading on the high-side of the refrigeration system to the computer.

______10. Sends the engine coolant temperature reading to the computer.

a. Sunload sensor
b. Low-pressure switch
c. Engine cutoff switch
d. Vehicle speed sensor
e. Refrigerant temperature sensor
f. Computer
g. Sunsight sensor
h. High pressure switch
i. Control head assembly
j. Low-side temperature switch
k. Engine temperature sensor
l. Electronic sensor
m. Ambient sensor
n. Outside temperature sensor
o. In-car sensor

_____11. Sends the refrigerant temperature reading on the low-side of the refrigeration system to the computer.

p. High-side temperature switch

OBJECTIVE 4 **Complete a chart that compares automatic and manual systems.**

Component	Manual system	Automatic system
1. Temperature control switch	Set ______ ______ ______	Set ______ ______ ______
2. Temperature control door	Controlled by a ______	Controlled by a ______
3. Vacuum motors function control airflow doors	Controlled by the ______	______ ______ adjusts pressure on all vacuum motors

OBJECTIVE 5 **Name sensors and switches that are required for an automatic system.**

______

______

______

NOTICE The following assignment sheets and job sheets are not part of the written test. If these activities have not been completed, check with your instructor.

OBJECTIVE 6 **Interpret system diagrams.** SCORE ______

OBJECTIVE 7 **Diagnose problems.** SCORE ______

OBJECTIVE 8a **Inspect and replace a sensor.** RATING ______

OBJECTIVE 8b **Inspect and replace a switch.** RATING ______

WRITTEN TEST ANSWERS

AUTOMATIC AND SEMI-AUTOMATIC CONTROLS

VI

OBJECTIVE 1

- Fan speed switch
- Temperature control switch
- Function control switch

OBJECTIVE 2

1. Function control switch
2. Inputs
3. Temperature control door
4. Airflow doors

OBJECTIVE 3

1. o
2. n
3. i
4. f
5. a
6. d
7. m
8. b
9. p
10. k
11. j

OBJECTIVE 4

Component	Manual system	Automatic system
1. Temperature control switch	Set on a scale of "HOT" to "COLD"	Set to a specific temperature
2. Temperature control door	Controlled by a cable	Controlled by a vacuum motor
3. Vacuum motors function control airflow doors	Controlled by the pressure switch	Computer adjusts vacuum that adjust air on all vacuum motors

OBJECTIVE 5

- Ambient sensor
- In-car sensor
- Low-pressure switch

OBJECTIVE 6

Refer to answers to Assignment Sheet 1.

OBJECTIVE 7 Refer to answers to Assignment Sheet 2.

OBJECTIVE 8 Refer to Practical Tests for Job Sheets 1 and 2.